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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
RICHARD SACHSE, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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OF
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QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXVII

STATE DIVISION OF MINES
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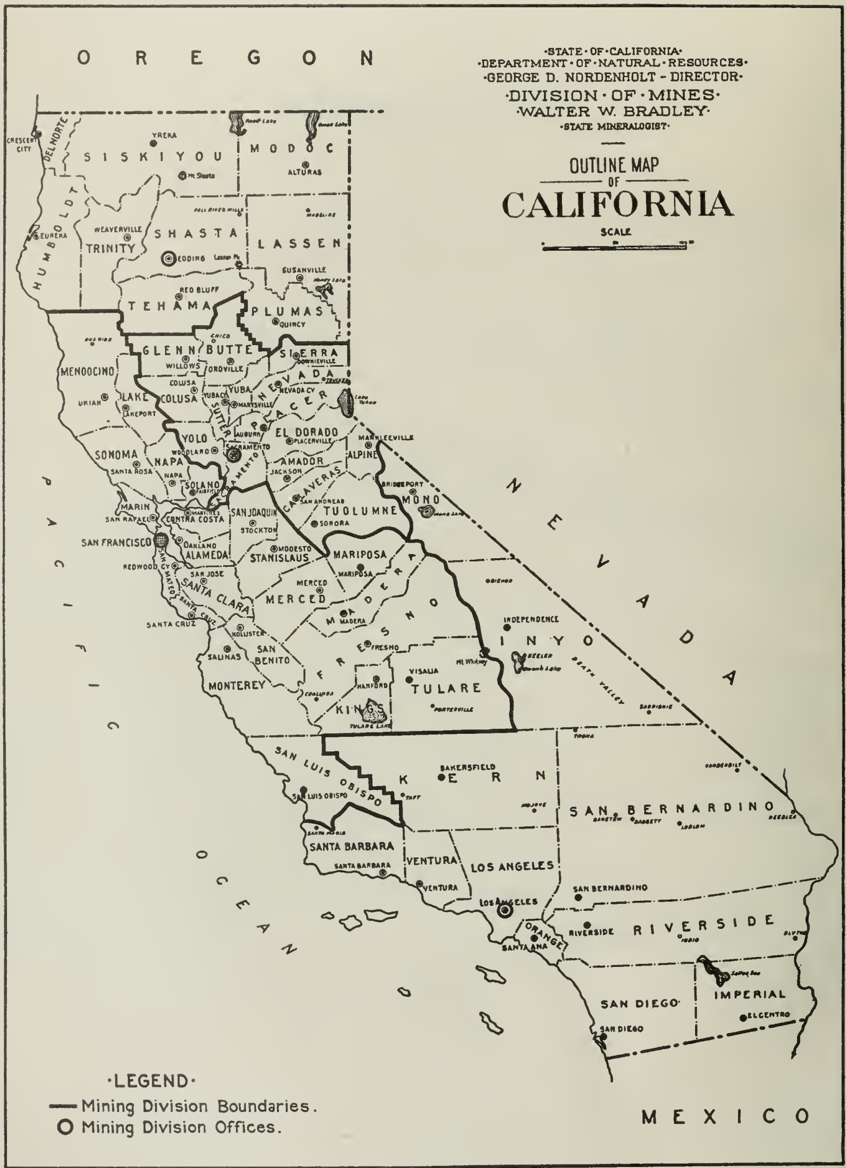
TABLE OF CONTENTS

Page
DISTRICT REPORTS OF MINING ENGINEERS 7
  Sacramento Field District 7
  San Francisco District 7
  Los Angeles District 7
  Redding Field District 8
    Mineral Resources of Trinity County, by Chas. Volney Averill 8
GEOLOGIC BRANCH 90
  Current Notes 90
  Strategic Minerals Procurement, by Charles White Merrill 91
  Geologic Investigation of the Chromite Deposits of California, by John Eliot Allen 101
SPECIAL ARTICLES 168
  United States Supreme Court Renders Far-reaching Decision on Power Permits on "Navigable" Streams 169
  Securities and Exchange Commission 184
ADMINISTRATIVE 190
MINERALS AND STATISTICS 191
  Statistics 191
  Museum 192
LABORATORY 194
LIBRARY 195
PRODUCERS AND CONSUMERS 200
EMPLOYMENT SERVICE 200
PUBLICATIONS I

ERRATUM

Figure 17, p. 63, and Figure 18, p. 66, should be interchanged.



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·DEPARTMENT·OF·NATURAL·RESOURCES·
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·STATE MINERALOGIST·

OUTLINE MAP
OF
CALIFORNIA

SCALE

·LEGEND·
— Mining Division Boundaries.
○ Mining Division Offices.

OREGON
NEVADA
MEXICO
PACIFIC OCEAN
CRESCENT CITY
DEL NORTE
SISKIYOU
YREKA
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
MENDOCINO
UKIAH
GLENN
WILLOWS
BUTTE
OROVILLE
CHICO
SIERRA
DOWNIEVILLE
NEVADA
NEVADA CY
LAKE
LAKEPORT
COLUSA
YUBA
MARYSVILLE
SUTTER
PLACER
AUBURN
YOLO
WOODLAND
SACRAMENTO
EL DORADO
PLACERVILLE
ALPINE
MARKLEEVILLE
SONOMA
SANTA ROSA
NAPA
SOLANO
FAIRFIELD
AMADOR
JACKSON
CALAVERAS
SAN ANDREAS
MONO
BRIDGEPORT
MARIN
SAN RAFAEL
CONTRA COSTA
MARTINEZ
SAN JOAQUIN
STOCKTON
TUOLUMNE
SONORA
SAN FRANCISCO
OAKLAND
ALAMEDA
MODESTO
STANISLAUS
MARIPOSA
REDWOOD CY
SAN MATEO
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SAN BENITO
SALINAS
FRESNO
INYO
INDEPENDENCE
MT. WHITNEY
DEATH VALLEY
MONTEREY
HANFORD
KINGS
TULARE
VISALIA
PORTERVILLE
SAN LUIS OBISPO
KERN
BAKERSFIELD
TAFT
MOJAVE
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
ORANGE
SANTA ANA
SAN DIEGO
IMPERIAL
EL CENTRO

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field District are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

On account of unfinished field work, there is no report from the Los Angeles Field District in this issue.

REDDING FIELD DISTRICT

Chas. Volney Averill, Mining Engineer

MINERAL RESOURCES OF TRINITY COUNTY

GEOGRAPHY.

Trinity County lies in the northwestern part of California, mostly in the heart of the Klamath Mountains, which in geologic makeup are similar to the Sierra Nevada, but which are separated from the latter by the northern end of the Sacramento Valley and the lavas of the Lassen Peak region. The southwestern corner of the county lies in the Coast Range. Humboldt County lies between it and the Pacific Ocean on the west, while Siskiyou County lies between it and the State of Oregon to the north. To the east are Shasta and Tehama, and to the south is Mendocino. Weaverville, the county seat, still retains some of the brick buildings erected in the gold-rush years between 1855 and 1860, following a disastrous fire. Population of the county by the census of 1930 was slightly over 2800 persons. The census of 1940 will no doubt show a substantial increase. The small population is due to the extremely mountainous condition of the area. The county is about 90 miles long in a north-south direction by 40 miles wide, and its area is 3096 square miles. Steep slopes are the rule throughout the county, with Thompson Peak in the Trinity Alps reaching an altitude of 8936 feet. It is about 20 miles a little west of north of Weaverville.

WATER SUPPLY.

The county contains most of the drainage basin of the Trinity River and its tributaries. A stretch of this river to the northwest of Trinity County lies in Humboldt County and in the Hoopa Valley Indian Reservation. The southwestern corner of Trinity County is drained by the Eel, Van Dusen and Mad rivers. For mining purposes, the Trinity River and its tributaries are of chief interest. Run-off in acre-feet[1] at various points for the water-year, 1934-1935, were as follows: Lewiston, 965,600; Burnt Ranch, 1,675,000; Hoopa, 3,438,000. Average discharge for 24 years at Lewiston is 1,394 second-feet, but the maximum has reached 31,900 second-feet, while the minimum was 23 second-feet on July 30, 1934. Due to the altitude, much of the county has considerable snowfall in winter. An exception to this is the southwestern part, which is near the coast, and has a climate somewhat like that of the coast.

AGRICULTURE.

Only a minor part of the land of the county is suitable for farming. The largest tracts are in the Hayfork and Hyampom valleys near the center of the county, totaling 15,000 acres. Another area of several thousand acres lies south of Trinity Center, and scattered tracts of much smaller area lie along the rivers. Horses and cattle numbering 7,800 head and 10,000 head of sheep and goats graze in the forest, but most of them must be moved out for the winter. Annual production of cereals, other grains, hay, forage, vegetables, fruits, nuts, garden products for home use, forest products cut on farms, dairy products, wool, poultry, and eggs totals about $300,000. Value of horses, mules, burros, cattle, swine, sheep, lambs, goats, and kids in the county is roughly $800,000.

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[1] Grover, N. C., Surface water supply of the United States, Part 11, Pacific slope basins in California, U. S. Geol. Survey Water Supply Paper 791, pp. 348-350, 1936.

TIMBER.

Trinity National Forest of 1,410,902 acres is not entirely within Trinity County, but a section of the Shasta National Forest in the northeast corner of the county more than makes up for portions of the Trinity Forest that lie in Humboldt, Tehama, and Shasta counties, so that more than 75 percent of the area of Trinity County, which totals 3096 square miles, is national forest land. The Trinity National Forest contains eleven billion feet of timber, of which 55 percent is Douglas fir, 25 percent western yellow pine, 13 percent sugar pine, 6 percent white fir, and the remainder incense cedar and red fir. Little timber has been cut because of the lack of railroad transportation in the county. A few semiportable mills cut lumber for local use. According to the United States Forest Service, several blocks of timber in the forest would furnish perpetual supplies of timber to sawmills if properly managed.

POWER.

Power lines of the Pacific Gas and Electric Company cross the county and serve Weaverville and points along Trinity River. The same company operates a small hydro-electric plant near Junction City with water from Canyon Creek. In many parts of the county electric power is not available, but a water-supply at a high head is often conveniently located so that small generators may be installed.

RECREATION.

Although Trinity County is not nearly as much developed to attract the tourist as many other parts of California, it does attract many hunters, fishermen, and persons who wish to make pack-trips to the glacial lakes and other points in the high mountains. Accommodations are available at Carrville, Trinity Alps Camp, Trinity Center, Forest Glen, and Coffee Creek. Several of the resorts maintain complete equipment for pack-trips into the mountains. The United States Forest Service has set aside large primitive areas in the Salmon-Trinity Alps (136,000 acres) and in the Middle-Eel-Yolla-Bolly region (77,086 acres). They also maintain camp-sites in the forest at various points, equipped with stoves, benches, tables and water-supply.

TRANSPORTATION.

The main artery of travel is the state highway from Redding to Weaverville and on to Eureka. In good weather, the 160 miles from Redding to Eureka can be driven in about six hours. Innumerable curves in the road as it winds up the mountains and along the river make greater speed hazardous. A second State highway branches at Douglas City to reach Hayfork and Forest Glen. It continues as a mountain road to the coast. The only railroad is the Northwestern Pacific to Eureka, which crosses the southwestern corner of the county. However, so many mountain ranges must be crossed to reach other parts of the county from this corner that, for all practical purposes, the county is without railroad service. Most of the roads to the mines are narrow dirt roads built on fairly steep grades.

GEOLOGY.

With the exception of an area comprising about one-third of the county in the eastern and northeastern parts, the geology of Trinity County has received little detailed study. Through the center of the county, belts of metamorphosed Paleozoic sediments, including quartzites, cherts, slates, limestones, and interbedded lavas and tuffs now altered to greenstones and amphibolite schists, strike in a northwesterly and southeasterly direction, and dip steeply, in a manner similar to that of the formations of the northwestern Sierra Nevada. A marked difference is the presence of belts of older schists, the Abrams mica schist and the Salmon hornblende schist, thought to be pre-Cambrian, but not yet actually proved to be so old. To the northeast are great intrusions[1] of acidic, intermediate (gabbro), and basic (altered to serpentine) igneous rocks, probably of late Jurassic age. In the southwestern corner of the county is a series of sediments thought to belong to the Franciscan (Jurassic?) formation, but this area has received little study. A small block of Cretaceous sediments unconformably overlies Paleozoic formations at Big Bar.

Gravels of several different ages have been mined for placer gold. The most productive have been the recent gravels in the channels of present streams and on the terraces. Some of the terrace-gravels, which have been extensively mined by the hydraulic method, are considered by Hinds[2] to be of Pleistocene age. He lists nine different locations in Trinity County where he believes that gravels of Pleistocene age occur at elevations of 50 ft. to 75 ft. above the beds of present streams. He considers them equivalent to the Red Bluff gravels of the Redding and Red Bluff quadrangles, and names them the Klamath gravels.

Still older gravels have been described by Diller,[3] Hershey,[4] and MacDonald,[5] notably at Weaverville, Redding Creek, Indian Creek, Hayfork, Hyampom, and Buckeye Ridge. Hinds[6] states that some confusion has existed regarding the age of these gravels. He now considers them to be of Eocene age. Apparently the gravels so extensively mined by the hydraulic method at the La Grange mine, west of Weaverville, belong to a fault-block of this series.

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[1] Averill, C. V., Preliminary report on economic geology of the Shasta quadrangle: Calif. State Mineralogist's Report XXVII, pp. 3-65 (map in pocket), January, 1931.

[2] Hinds, N. E. A., Geologic formations of the Redding-Weaverville districts, northern California: Calif. State Mineralogist's Report XXIX, pp. 120-121 (map in pocket), 1933.

[3] Diller, J. S. Topographic revolution in the topography of the Pacific Coast: U. S. Geol. Survey, 14th Ann. Rept., p. 419, 1894. The auriferous gravels of the Trinity River basin: U. S. Geol. Survey, Bull. 470, pp. 11-29, 1911. Auriferous gravels of the Weaverville quadrangle: U. S. Geol. Survey, Bull. 540, pp. 11-21, 1914.

[4] Hershey, O. H., The Sierran valleys of the Klamath region; Jour. Geol., vol. 11, p. 157, 1903.

[5] MacDonald, D. F., The Weaverville-Trinity Center gold gravels, Trinity County, California: U. S. Geol. Survey, Bull. 430, pp. 48-58, 1910.

[6] Hinds, N. E. A., *op. cit.*, pp. 115-116.

Further details on geology are included in the following section on mineral resources, and in descriptions of individual mines. For still further details reference should be made to the works cited in the footnotes. The following, which describe the geology of parts of Trinity County, are for sale at offices of the State Division of Mines, except the Redding office: Geologic Formations of the Redding-Weaverville Districts, Northern California, by Norman E. A. Hinds, California Journal of Mines and Geology, combined issue of January and April, 1933 (including a separate report on the gold mines by Chas. V. Averill); Preliminary Report on Economic Geology of the Shasta Quadrangle, by Chas. V. Averill, Mining in California, January, 1931.

Diller[1] describes two peneplains, the Klamath and the Sherwood, in this region, which are thought to be the result of erosion in Cretaceous and Tertiary time. Probably this accounts for the peculiar meanders of Trinity River as it winds through the mountains. If the meanders developed on a flood-plain during one of these cycles of erosion, and then the land was gradually elevated at about the same rate as the river was able to cut a channel, the meanders would become intrenched in the bedrock as we see them today. A detailed study of the terrace-gravels at Salyer, which are found at various altitudes clear to the top of the ridge, more than 1000 ft. higher than the present river, would probably shed additional light on the history of this cycle of erosion.

MINERAL RESOURCES.

By far the most important mineral product of the county is placer gold recovered by dredging. Large dredges of the bucket-ladder or connected bucket type are operated in Trinity River at Junction City and Lewiston. Weaverville is enjoying a period of prosperity due largely to a number of dragline dredges operated on Trinity River and tributaries in that vicinity. The dredging in Trinity County has been described in a recent publication[2] of this division, which is still available. Hence descriptions of dredges in this report will be confined to new developments.

Hydraulic mining is still of considerable importance in the county, although operations are on a smaller scale than in the past. High terraces of Trinity River are most extensively worked, also a few of the tributaries. Principal locations are at Salyer, Helena, Canyon Creek near Dedrick, Junction City, Trinity Center, and Coffee Creek.

Small-scale placer mining is still practiced in the county but affords small returns. Probably the average small-scale miner earns enough for a bare living only during good weather. The best of the small-scale placer deposits were worked out by the end of 1853. The white miners were followed by Chinese, who worked the same ground a second time and cleaned it very thoroughly so far as small-scale methods are concerned. Some of the large dredges still find the few cents per cubic yard needed to pay for this method in ground that has already been worked by hand. Flood waters of the Trinity River still concentrate gold in places, and men may be seen every spring working these concentrations with "dip-boxes." The return is small.

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[1] Diller, J. S., *op. cit.*, Bull. 470, pp. 12-13.

[2] Averill, C. V., Gold Dredging in Shasta, Siskiyou and Trinity Counties: Calif. State Mineralogist's Report XXXIV, pp. 96-126, April, 1938.

At the present time quartz mining is of minor importance to dredging. Several quartz mines have been important producers but all are working on a reduced scale now. The Brown Bear has been the best in the county as well as the best in its district, the Deadwood District, which continues easterly into Shasta County as the French Gulch District. From a geological standpoint, these two districts form a single district. The gold is associated with dikes of several kinds, mostly diorite porphyry ("bird's-eye porphyry") intruded into the Bragdon formation (Carboniferous), largely black carbonaceous slate, but with some cherty conglomerate. The carbon in the slate seems to have acted as a precipitant of the gold in some of the best oreshoots, but some excellent shoots have been found at a distance from the slate also. A vertical section showing geological conditions in the Brown Bear mine was published[1] in California Journal of Mines and Geology, combined issue of January and April, 1933. This publication is still available. The ore is usually white quartz with free gold and one percent to four percent of auriferous sulphides, pyrite, sphalerite, galena and arsenopyrite. Galena is usually an indication of a high gold content. A little production is being made from small mines to the north of the Brown Bear, the Venecia, the Paymaster, and the Starvation (Lewis).

From the Cleveland and Bully Choop mines on the eastern countyline, a belt of Salmon hornblende schist extends in a northwesterly direction. Quartz veins in this formation have been productive, notably at the Globe mine near Dedrick. Other mines in this belt are the Mason and Thayer, Maple, Ralston, Meckel-Fields, and Patillo.

Quartz veins carrying gold also occur in the vicinity of Coffee Creek west of Carrville. They have been described by MacDonald.[2] The veins are associated with dikes of several varieties of lamprophyre intruded into granodiorite. Recent activity has consisted of prospecting and development work at the Golden Jubilee, Dorleska, and others.

A recent development of interest is at the Kelly mine near Hayfork. Highgrade gold ore occurs in flat quartz veins in a practically vertical andesitic dike. The dike has been intruded into a series of cherts and slates, possibly the Chanchelulla formation of Hinds.[3]

Next in importance to gold is the quicksilver production of the old Altoona district. The Altoona mine has been equipped with a modern furnace and is producing.

Mineral resources of Trinity County include asbestos, barite, chromite, coal, copper, gold, limestone, manganese, marble, mineral paint, mineral water, platinum group metals, quicksilver, and miscellaneous stone. These are described in more detail in alphabetical order on the following pages. Production since 1880 (quicksilver earlier) is shown on the accompanying table.

---

[1] Averill, C. V., Gold deposits of the Redding and Weaverville quadrangles: Calif. State Mineralogist's Report XXIX, pp. 3-73, 1933 (with map in pocket).

[2] MacDonald, D. F., Notes on the gold lodes of the Carrville District, Trinity County, California: U. S. Geol. Survey Bull. 530-D, pp. 1-37, 1912.

[3] Hinds, N. E. A., Geologic formations of the Redding-Weaverville districts, northern California: Calif. State Mineralogist's Report XXIX, pp. 85-86, 1933.

Year	Gold, value	Silver, value	Quicksilver	
			Flasks	Value
Altoona Mine, before 1875 (estimated)*	(6)	(6)	1,000	$88,000
1875	---	---	1,500	126,425
1876	---	---	1,979	87,076
1877	---	---	1,317	49,129
1878	---	---	1,534	50,469
1879	---	---	1,919	57,282
1880	$326,693	$142	245	7,595
1881	550,000	1,500	---	---
1882	600,000	---	---	---
1883	400,000	---	---	---
1884	529,150	[2]334	---	---
1885	338,148	10	---	---
1886	464,726	219	---	---
1887	553,051	924	---	---
1888	589,000	500	---	---
1889	811,632	640	---	---
1890	1,192,790	259	240	12,600
1891	1,327,787	2,249	---	---
1892	1,446,603	168	---	---
1893	1,122,995	---	---	---
1894	1,012,666	325	---	---
1895	1,166,745	1,257	3,926	137,410
1896	1,296,330	---	4,205	139,035
1897	1,078,372	259	838	29,330
1898	859,255	314	4,032	151,200
1899	590,510	1,086	3,076	123,624
1900	571,605	[3]7,935	2,294	105,982
1901	684,683	[3]1,240	1,302	58,668
1902	719,992	550	240	10,251
1903	607,728	2,085	266	11,156
1904	574,814	135	[7]102	3,864
1905	690,844	3,044	389	13,917
1906	560,843	2,981	166	6,059
1907	535,316	2,399	98	3,739
1908	602,944	4,269	90	3,808
1909	520,046	2,302	197	7,915
1910	500,851	1,960	133	5,622
1911	612,149	6,777	44	2,024
1912	723,503	7,494	18	758
1913	431,862	2,119	4	161
1914	743,512	3,374	---	---
1915	441,846	3,470	(4)	---
1916	435,493	7,591	(4)	---
1917	602,048	10,021	(4)	---
1918	444,729	6,912	(4)	---
1919	538,494	3,872	(4)	---
1920	541,387	3,469	(4)	---
1921	437,993	1,390	---	---
1922	182,918	2,432	---	---
1923	617,841	5,816	---	---
1924	422,281	10,934	---	---
1925	424,037	7,724	---	---
1926	483,471	13,276	---	---
1927	409,492	12,326	---	---
1928	402,694	12,258	---	---
1929	352,029	10,269	(4)	---
1930	330,003	6,700	(4)	---
1931	292,031	532	(4)	---
1932	294,297	608	(4)	---
1933	345,851	768	(4)	---
1934	574,681	1,640	(4)	---
1935	727,787	2,506	(4)	---
1936	708,715	2,251	(4)	---
1937	703,780	2,099	(4)	---
1938	1,451,345	2,992	(4)	---
1939	1,488,550	3,176	(4)	---
Totals	$38,990,938	$193,884	[4]31,154	[4]$1,293,099

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* Bradley, W. W., Quicksilver resources of California; Cal. State Min. Bur., Bull. 78, p. 200, 1918.

[1] Includes crushed rock, rubble, sand, gravel.

[2] Lawyer, A. M., in 'Production of Precious Metals in U. S.'; Report of Director of Mint, 1884, p. 175, 1885.

[3] Recalculated to 'commercial' from 'coining value' as originally published.

TRINITY COUNTY, 1875-1939

Platinum		Miscellaneous stone[1], value	Miscellaneous and unapportioned		
Ounces	Value		Amount	Value	Substance
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-----	-----	-----	3,620 cu.ft.	$5,000	Granite.
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-----	-----	-----	500 cu.ft.	375	Granite.
-----	-----	-----	5,750 cu.ft.	4,535	Granite.
-----	-----	-----	4,838 lbs. 6,870 cu.ft.	761 5,500	Copper. Granite.
39	$468	-----	-----	-----	
13	200	-----	100 cu.ft.	75	Granite.
11	275	-----	-----	-----	
26	450	-----	-----	-----	
7	130	-----	-----	-----	
(4)	-----	-----	-----	-----	
(4)	-----	-----	-----	-----	
(4)	-----	-----	-----	111,307	Unapportioned, 1900-1909.
(4)	-----	-----	-----	-----	
(4)	-----	-----	-----	-----	
(4)	-----	$2,000	-----	-----	
(4)	-----	1,000	-----	-----	
5	151	-----	-----	245	Mineral water.
13	435	900	120 gals. -----	360 52,500	Mineral water. Other minerals.
113	5,161	1,000	-----	397,316	Chromite, copper, manganese, mineral water, quicksilver.
50	3,283	7,718	242 tons -----	6,325 358,447	Chromite. Copper, manganese, mineral water, quicksilver.
41	3,136	1,513	1,814 tons -----	75,660 175,574	Chromite. Copper, mineral water, quicksilver.
(4) (5) fine ounces	-----	11,839	-----	17,444	Copper, mineral water, platinum, quicksilver.
37	6,612	8,799	-----	1,838	Other minerals.
27	3,260	(4)	-----	14,239	Quicksilver, miscellaneous stone.
12	1,223	5,677	-----	5,687	
18	2,050	3,000	329,706 lbs.	48,467	Copper.
11	1,839	2,240	550,000 lbs.	72,050	Copper.
26	3,081	5,000	439,766 lbs.	62,447	Copper.
28	2,832	-----	760,140 lbs. -----	106,420 4,000	Copper. Other minerals.
-----	-----	32,250	770,882 lbs. -----	100,986 800	Copper. Other minerals.
(4)	-----	12,084	660,142 lbs. -----	95,060 8,084	Copper. Chromite and platinum.
-----	-----	41,867	615,579 lbs. -----	108,342 13,367	Copper. Chromite, coal, quicksilver.
(4)	-----	4,238	588,574 lbs. -----	76,514 19,878	Copper. Coal, platinum, quicksilver.
31	993	20,246	-----	14,720	Coal, quicksilver.
19	473	17,160	295 lbs. -----	8 12,729	Lead. Coal, quicksilver.
(4)	(4)	2,375	-----	10,509	Coal, lead, platinum, quicksilver.
(4)	(4)	62,522	359 lbs. -----	29 11,748	Copper. Coal, platinum, quicksilver.
(4)	(4)	3,803	-----	11,090	Coal, copper, lead, quicksilver.
(4)	(4)	7,867	-----	5,276	Coal, copper, lead, platinum, quicksilver.
155	7,052	(4)	-----	8,359	Coal, quicksilver, miscellaneous stone.
(4)	(4)	36,456	-----	2,339	Coal, platinum.
(4)	-----	16,177	-----	7,048	Copper, platinum, quicksilver.
[4]682	$43,104	$307,731	-----	$2,038,458	

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[4] See under 'Unapportioned.'

[5] The metal contained in the 1919 product was 38% iridium and 62% platinum.

[6] No county segregated figures for gold and silver available for years earlier than 1880.

[7] Flasks of 76½ pounds previous to June, 1904; of 75 pounds thence, through 1927; of 76 pounds since January, 1928.

ASBESTOS.

Amphibole asbestos occurs at a number of points near the Altoona quicksilver mine at distances of five to 15 miles from it. Some years ago an attempt was made to work one of these deposits, and machinery was installed, but the operation was not profitable. Chrysotile asbestos has been found at a number of places in the serpentine, notably near Carrville and near Highland Lake on the eastern county-line. Actual production has been made as follows:

Jones Brothers Asbestos Supply Company mined asbestos from leased railroad land in Sec. 7, T. 37 N., R. 7 W., a quarter of a mile west of the Coffee Creek bridge, where the main road from Carrville to the north crosses. This company was located at 370 Second Street, San Francisco. A crew of five men was at work in 1930, hand-cobbing and sorting the asbestos from the serpentine in which it occurs. Mining was from an open cut, 8 ft. by 20 ft. and 7 ft. deep. The asbestos was green chrysotile of apparently very good quality with considerable strength of fiber. The length varied from a quarter of an inch to two inches, with an average of three-quarters of an inch. It was sacked for shipment, and was stated to be worth $380 per ton.

BARITE.

In Bulletin 113 of this division, an occurence of dark-gray barite is noted at a point 15 miles below Hayfork. So far as is known no commercial production has been made.

CHROMIUM.

Many small lenses of chromite are found in the serpentines of Trinity County. A number of them were mined out during the war of 1914-1918. Claims held at that time are listed in Bulletin 76[1] of this division. Due to the lack of interest in chromite for a long period of years, which ended just recently, many of the claims held in 1918 were allowed to lapse. Much of the same ground is covered by claims listed below. Since September 15, 1935, discovery work has been required within 90 days of the date of location of a claim. This requirement has probably not been met by some of the locators listed below, and in such cases the ground is open to relocation and may have been relocated.

Visiting all of the small lenses now known to exist in the county has not been practicable during the present survey. Intensive prospecting would doubtless result in the discovery of many more. The principal districts are near the Altoona quicksilver mine in the high mountains east of Trinity Center and in a large area south of Hayfork. Ocurrences listed below are representative of those so far found in Trinity County.

Arrow Point Chrome Mine was located on November 9, 1939, by Floyd Sublett of Redding. The location notice describes it as being in the Forest Glen District, three miles southwest of Round Mountain on the southeast slope of Dark Canyon Creek. It is believed to be in Sec.

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[1] Bradley, W. W., Huguenin, E., Logan, C. A., Tucker, W. B., Waring, C. A., Manganese and Chromium in California: California Min. Bur. Bull. 76, pp. 209-212, 1918.

24, T. 28 N., R. 11 W., M.D.M. Sublett states that two outcrops of chromite, 2½ ft. in diameter, are found at a distance of 100 ft. apart. The width seems to be getting greater as depth is attained. The line of the two outcrops follows a ridge in a northwest and southeast direction. Only discovery work has been done. The claim is about 65 miles from Redding and is reached by means of a steep mountain road turning from the county road near Harrison Gulch.

Black Crane claim was located on May 10, 1940, by J. A. Buckley and Bud Wagner of Trinity Center, in Sec. 14, T. 38 N., R. 6 W., M. D. M. It is 20 miles west of Castella by a steep mountain road at an altitude of 5000 ft to 6000 ft. The Crow Creek guard station of the U. S. Forest Service is near the road, on the same ridge as the claim, at a distance of about a quarter of a mile southwest of the claim. A lens of chromite was evidently removed during the war of 1914-1918 from a cut, 10 ft. long, 4 ft. wide, and 10 ft. deep, now partly caved. Other cuts on the claim indicate that other lenses of similar size were mined, probably not quite so deep. This claim may conflict in part with the Black Crow No. 1 and No. 2 of Richard H. Williams listed below. It probably covers some of the same ground as the Crow Creek Group described in our Bulletin 76.

Black Crow No. 1 and Black Crow No. 2 are two claims in Sec. 18, T. 38 N., R. 5 W., M. D. M., held by George L. Costa, Box 16, Castella. The claim is 20 miles west of Castella by steep mountain road at an altitude of 6000 ft. Costa states that he has 30 tons of mined chromite on Black Crow No. 1 and that no more is in sight. On Black Crow No. 2 are three or four outcrops, each measuring 3 ft. to 4 ft. in both dimensions, on which development work must be done to determine their extent. These claims were located on May 15, 1935.

Black Crow No. 1 and No. 2 are two claims located and recorded in November, 1939, by Richard H. Williams, 2844 Alhambra Boulevard, Sacramento, and others. They are described as being in Cinnabar Mining District on the ridge 500 ft. above the Ramshorn road between two branches of Crow Creek near Crow Creek Guard Station, which point is west end center. They are apparently in Sec. 14, T. 38 N., R. 6. W., M. D. M. See Black Crane, which is listed above.

Brown Dog is a claim located on October 3, 1939, by Elmo Pickering and Bud Wagner, Trinity Center, in the Mumbo Creek District, one mile south of Mumbo Basin. The approximate location is Sec. 2, T. 38 N., R. 6 W., M. D. M.

Cedar Camp is a claim located on February 25, 1940, by Fred Werseen of Igo, Shasta County. It is described as being in the Hayfork District, 150 ft. northwest from the fork of Post Creek and Hayfork Creek. This must be a different Post Creek from the one that flows into South Fork of Trinity River near Forest Glen, and the legal subdivision is not known. A request for further information addressed to the locator remains unanswered.

Chrome No. 2 is a claim located on October 5, 1938, by Sillon Walker Massey, c/o Ed. J. Aherin, 3442 E. 17th Street, Oakland, in the

Halls Gulch District. It must be in or near Sec. 3, T. 36 N., R. 6 W., M. D. M.

Empire is a claim in Sec. 31, T. 30 N., R. 12 W., held by Alvis Rais and E. Phair, Forest Glen. It is a quarter-mile by trail southeast of a point on the Forest Glen-Hayfork road, six-tenths of a mile east of North Post Creek. The distance to Hayfork over dirt road is 16 miles. Hayfork is 66 miles from Redding by oiled road. The altitude at the claim is 3000 ft. Chromite lenses in serpentine, from a few inches wide to 18 inches wide, have been followed almost continuously for a length of 200 ft. by means of trenches of a maximum depth of 5 ft. A few tons of mined chromite are on dumps and several tons additional are in sight in exposed lenses. Hand-sorting is needed to produce a good grade of chromite.

Green Stripe Chrome Mine No. 1 and No. 2 are two claims in Sec. 8(?), T. 38 N., R. 6 W., M. D. M., located on August 28, 1937, by George Anderson, Box 16, Castella, and George L. Costa, Box 16, Castella. They are described as being on the east side of Mumbo Creek near Chrome Gulch. Costa thinks that they may have been relocated in the spring of 1940 by Bud Wagner, Trinity Center.

Hoelling Claims are near the corner common to Sec. 20, 21, 28, 29, T. 1, N., R. 8 E., H. M., at an altitude of 4000 ft. Henry W. Hoelling, Hayfork, states that he found an outcrop of chromite on the ridge near the head of North Post Creek, and that he located mining claims there in the summer of 1940. The outcrop is stated to be 4 ft. by 10 ft. In this same general vicinity is a pile of roughly 20 tons of chromite that was mined during the war of 1914-1918. It is at the edge of the Forest Glen-Hayfork road at a point two miles east of Forest Glen. Hoelling states that it was mined about a mile north of the point where it now lies.

Integral Quicksilver Mine includes a number of patented mining claims and large tracts of timber land in Sec. 15, 22, 23, T. 38 N., R. 6 W., M. D. M. Chromite was found on parts of this property during the war of 1914-1918. It is now assessed to Zack Anderson, Box 162, Middletown, Lake County. Very little work has been done here recently, and many of the buildings are in a wrecked condition.

Little Ann Chrome Mine and Mumsie A. Chrome Mine are two adjoining claims in the Tule Creek District, Sec. 30, T. 31 N., R. 12 W., M. D. M., held by Delmar E. Frye and wife, California B. Frye, Hayfork. Altitude is 4000 ft. The claims are on a road recently built along Tule Creek to Indian Valley. The distance to Hayfork by dirt road is 6 miles. From Hayfork to Redding, it is 66 miles over oiled roads. About 20 tons of chrome ore that appears to be of good grade has been mined and is still on the ground. It occurs in small lenses in the serpentine at various points on both claims. Individual lenses contain from a ton to two tons each. Frye is considering scraping the surface of the claims with a bulldozer to prospect for more of these small lenses. Some chrome ore was produced here during the war of 1914-1918.

Lost Dog Chrome Mine is a claim in Sec. 34 (?), T. 31 N., R. 12 W., held by Alvin Cottrill, 1778 Roanoke Avenue, Redding. It adjoins the Maringer Chrome Mine, which is listed below.

Maringer Chrome Mine is a claim in Sec. 34(?), T. 31 N., R. 12 W., M. D. M., 80 miles west of Redding, held by Frank Maringer, 1746 Roanoke Avenue, Redding. Altitude is 3500 ft. A new road to Plummer Peak near Peanut reaches a point about a mile from the claim, but no trail has been made, and one must go cross-country on steep slopes. Chrome ore to the amount of 13 tons was mined from this claim during the war of 1914-1918 and was packed four miles on horses to the road. It was taken from a 30-ft. incline shaft. This is said to expose a width of one foot of chromite for a length of 20 ft. at the present time. Due to water in the shaft, only the upper part could be seen at the time of our visit. Shaft-timbers need repairing. Maringer relocated the claim on September 12, 1939, and only discovery work has been done.

The body of serpentine in which this lens occurs appears to be at least three miles long by a mile wide; hence other lenses may be found. The Lost Dog and the Tuly Creek claims adjoin. Ownership of these is listed elsewhere in this report.

Mumsie A. Chrome Mine is one of two claims held by Delmar E. Frye and wife, Hayfork. See Little Ann, which is listed above.

Munko, J. A., Mercury Mine is a claim located by Philip C. Munko, Castella, on September 14, 1939, at the old 'chrome camp,' in Sec. 14, T. 38 N., R. 6 W., M. D. M., in the mountains, 20 miles west of Castella, at an altitude of 5000 ft. A crew of men engaged in mining chrome ore was housed here during the war of 1914-1918. Two of the old buildings still stand, but they are in need of extensive repairs.

Pink Crystal is a claim located in 1939 by Elmo Pickering and Bud Wagner of Trinity Center. It is described as being on the slope of the East Fork of Trinity River, two miles east of the Altoona mine and one mile west of Soda Spring. It must be in or near Sec. 25, 26, T. 38 N, R. 6 W., M. D. M.

Red Mountain is a claim located on November 15, 1939, by P. A. Pesula, Scotia. It is described as being on Red Mountain, one mile east of Red Mountain House known as Doolittle place. This is about on the line between Sec. 20, 21, T. 26 N., R. 12 W., M. D. M., in the southern part of Trinity County. Shipping point would probably be Eureka, which is more than 100 miles away. A large part of the road is mountain road, and a pack-haul of at least 6 miles from the claim to the nearest road is involved.

Summit is a claim located in 1939 by Elmo Pickering and Bud Wagner, Trinity Center. It is described as being 300 ft. south of the Castella road and one-half mile northwest of Soda Spring. It must be in or near Sec. 23, 24, 25, 26, T. 38 N., R. 6 W., M. D. M.

Sunny Slope and *Cedar Junction* are two claims in Sec. 10, T. 29 N., R. 11 W., M. D. M., held by E. A. Collins of Ono. The *July Chrome Claim* adjoining the Cedar Junction is held by David Boyer, Ono. Serpentine crops out in all parts of this section examined;

hence it appears to occur in quite an extensive body. The Sunny Slope is in the southeastern part of Sec. 10, and there Collins is driving an open cut in the serpentine to prospect for chromite. The Cedar Junction is half a mile to the northwest and 500 ft. higher in altitude. Old open cuts indicate that chromite was mined during the war of 1914-1918. Chunks of chromite are found mixed in the gravel of a small gulch, and outcrops of chromite, a few inches in width, are seen higher on the mountain. Altitudes above sea level vary from 3500 to 4000 ft.

Trinity Chrome Mine is a claim in Sec. 35, T. 37 N., R. 6 W., M. D. M., located by C. L. Proebstel, Redding, G. B. Reed, A. W. Thompson, and C. R. Stryker. Proebstel has brought specimens of the chromite to Redding that appear to be of good grade. The claim is on the divide between Trinity and Shasta counties, 12 miles west of Lamoine. About five miles of new road are needed to reach it from existing roads.

Tuly Creek Chrome Mine is a claim in Sec. 34(?), T. 31 N., R. 12 W., M. D. M., held by Rollin Maringer, 1746 Roanoke Avenue, Redding. It adjoins the Maringer Chrome Mine, which is described above.

Twin Chrome Hill Mine is a claim in Sec. 14 (?), T. 38 N., R. 6 W., M. D. M., held by Emile Chestang, Box 639, Mt. Shasta. It is 20 miles west of Castella by steep mountain road, at an altitude of 5000 ft. Chestang states that the chromite outcrops for a width of 4 ft. and a length of 12 ft., with another outcrop 150 ft. distant, and that he has mined four tons of chromite.

Wild Cat Chrome Mine is a claim located in the Halls Gulch District by A. D. Grafton, Lamoine, and others. Halls Gulch is in Sec. 5, 6, T. 36 N., R. 6 W., and Sec. 31, 32, 33, T. 37 N., R. 6 W. About five miles of new road is needed to reach this district.

COAL.

Lignite occurrences in Trinity County have been described in several reports of the State Mineralogist, notably Report XII for 1893-1894. New data on developments at Big Bar and at the Reese mine near Browns Creek are given below; also new data on the age of the coal at Big Bar, which has been found to be older than formerly thought. The Big Bar coal is at least as old as Cretaceous, possibly as old as Jurassic, while the other coals or lignites are probably of Eocene age. The Big Bar coal has the appearance of being higher in quality than other coals and lignites found in northern California, but analyses of it are not available.

Big Bar. Coal was exposed here in the bedrock of a gravel deposit that was mined by the hydraulic method. It is only a few hundred feet south of Trinity River and roughly 50 ft. higher than the present river, in Sec. 5, T. 33 N., R. 12 W., M. D. M. Coal has been mined here at various times since 1929 by R. F. Riley of Big Bar and others. The truck-haul of roughly 80 miles to railroads in either direction, Redding and Eureka, makes transportation quite a problem. A few truck-loads have been hauled to both places, and some of the coal has been used locally in Trinity County, but the mine has been idle for several years. It is on the public domain, and a royalty was paid to the United States on the last coal mined. Patented tracts adjoining are owned by Sadie D. Campbell, C. M. O'Neil, and W. A. Pattison of Big Bar.

The coal has a southerly strike and a dip of 30° to 40° west and is interbedded with shale and fine-grained sandstone. A number of beds occur in a width of the formation of 20 ft., but only one bed contains good coal in widths of 3 ft. to 5 ft. The other beds contain considerable shale. Fossils have been collected by the writer from a point about a mile west of the main workings, and hence considerably higher stratigraphically. They were found in Sec. 6, T. 33 N., R. 12 W. F. M. Anderson identified them as *Aucella Crassicollis,* Keyserling, and they are now in the collection of California Academy of Sciences, Golden Gate Park, San Francisco. According to a recent report by Anderson[1] they indicate that the strata belong to the Paskenta formation (Lower Cretaceous). As the coal is considerably lower stratigraphically, it may be in the Knoxville formation, which some geologists consider Cretaceous in age, others Jurassic. A seam of coal about a foot in width occurs about 50 ft. stratigraphically below the point where the fossils were found. The main workings are near the base of the series, and outcrops of slates and schists of probable Paleozoic age are seen just to the east. The Cretaceous (with some possibly Knoxville) strata have been found only on the south side of Trinity River. They are not in evidence north of the river.

Hayfork Valley. In the river one and two miles downstream from Hayfork, two outcrops of lignite were found many years ago, and were described in past reports of the State Mineralogist, particularly Report XII for 1893-1894. The coal is described as black, tough lignite of good quality, and three separate seams, five, one, and six feet in thickness, respectively, were noted. It is of Tertiary age, probably Eocene.

Hyampom Valley. In this valley where Hayfork Creek flows into South Fork of Trinity River, numerous outcrops of lignite have been noted and described in State Mineralogist's Report XII. Some of the seams of lignite are 8 ft. to 10 ft. thick, and are said to be of good quality, resembling other lignites found in Amador County and the Mount Diablo region. Only a little prospecting has been done on these outcrops. Hyampom is nearly 90 miles by road from the nearest railroad. Undeveloped lignite in Sec. 13, 14, 23, 24, T. 3 N., R. 6 E., is owned by Mrs. B. R. Hinckley, Rohnerville.

Poison Camp. A seam of lignite, three feet thick, at this location, Sec. 15, 22, T. 2 S., R. 6 E., H. M., is described in State Mineralogist's Report XII.

Redding Creek. In this locality, Diller[2] noted a bed of shaly coal 5 to 15 feet thick interstratified with gravel, shale, and tuff. The area is seven miles southeast of Douglas City.

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[1] Anderson, F. M., Jurassic and Cretaceous divisions in the Knoxville-Shasta succession of California: Calif. State Mineralogist's Report XXVIII, pp. 311-328, 1932.

[2] Diller, J. S., The auriferous gravels of the Trinity River basin, California: U. S. Geol. Survey Bull. 470, p. 20, 1911.

Reese Bros. Mine is in this same general area southeast of Douglas City on the Browns Creek drainage, Sec. 32, T. 32 N., R. 9 W. Reese Bros., Box 14, Douglas City, and others sank a slope on this sub-bituminous coal and sold small lots in Redding. At a distance of 100 ft. southwest of the portal of the slope is a cut exposing a width of 8 ft. of impure lignite or sub-bituminous coal interbedded with a very fine-grained, nearly white volcanic ash. The strike is S. 50° to 70° W. and the dip about 20° SE. Reese Bros. and others filed an application for a new lease on this coal with the U. S. General Land Office in 1940. The property was idle when it was visited in 1939.

The following analyses of the coal were made in the laboratories of the U. S. Bureau of Mines.[1]

Sample of dry cuttings from a hole drilled in the roof, at a distance of 118 ft. from the portal of the slope at a depth below the surface of about 50 ft., coal 1 ft., 3 inches in thickness, not weathered:

Air-dry loss 15.6	Coal (air dried)	Coal (as received)	Coal (moisture free)	Coal (moisture and ash free)
Moisture	13.3	26.8		
Volatile matter	38.6	32.6	44.5	55.8
Fixed carbon	30.5	25.7	35.2	44.2
Ash	17.6	14.9	20.3	
	100.0	100.0	100.0	100.0
Hydrogen	5.5	6.4	4.6	5.8
Carbon	46.7	39.4	53.8	67.5
Nitrogen	.9	.7	1.0	1.2
Oxygen	28.2	37.7	19.1	24.0
Sulphur	1.1	.9	1.2	1.5
Ash	17.6	14.9	20.3	
	100.0	100.0	100.0	100.0
British Thermal Units	8120	6850	9360	11750

Softening temperature of ash 2210° F.

Sample of dry, fresh coal, right rib, 122 ft. from portal. Roof: coal.

Floor: shale. Vertical depth from surface to point of sampling: 50 ft.

No.	Section of Bed	ft.	inches
x1	Coal	1	3
2	Coal	1	2
x3	Dirty coal	0	5½
4	Coal	1	10½
x5	Soft shale	0	2
6	Coal	2	10
	Total thickness of bed	7	9
	Thickness in sample	5	10½

Excluded from sample, marked x, section Nos. 1, 3, and 5.

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[1] Analyses B-30709 and B-30710 published by permission of the Director, U. S. Bureau of Mines, Washington, D. C.

Air dry loss 10.8	Coal (air dried)	Coal (as received)	Coal (moisture free)	Coal (moisture and ash free)
Moisture	12.3	21.8		
Volatile matter	37.6	33.5	42.9	57.8
Fixed carbon	27.5	24.5	31.3	42.2
Ash	22.6	20.2	25.8	
	100.0	100.0	100.0	100.0
Hydrogen	5.3	5.9	4.4	6.0
Carbon	43.9	39.2	50.1	67.5
Nitrogen	.7	.7	.8	1.1
Oxygen	26.2	32.8	17.4	23.4
Sulphur	1.3	1.2	1.5	2.0
Ash	22.6	20.2	25.8	
	100.0	100.0	100.0	100.0
British Thermal Units	7720	6890	8810	11870

Softening temperature of ash—2200° F.

Copies of these analyses prepared by the U. S. Bureau of Mines include the following: This report is in a public file in the Bureau of Mines and it is not to be used, in full or in part, for advertising or sales promotion purposes without permission of the Director of the Bureau of Mines. The first analysis is of the top coal; the second is a face sample, cut below the top coal.

COPPER.

Copper prospects are found in areas of peridotite and serpentine and on their contracts with other rocks in New River district, Carrville-Trinity Center district, adjacent to South Fork of Trinity River between Hyampom and Rattlesnake Creek, and in extreme southwestern corner of the county, where geologic conditions are different and where the only important producer has been developed. All of these districts except the last named are so far from railroads that little has been done with the prospects. It costs so much to haul ore to the railroad that only a very rich ore or concentrate would yield any profit. This applies to all districts except the Island Mountain district in the southwestern corner of the county, which is practically on the railroad. No active mining or prospecting of copper properties has been done lately. For information on former activity, reference should be made to the reports mentioned below.

Bibl.: Calif. State Division Mines Bull. 50, pp. 140-150, 1908; State Mineralogist's Reports XIV, pp. 878-882, 1913-14; XXII, pp. 14-15, 1926; U. S. Geol. Survey Bull. 530-D, pp. 25-26, 1912.

Island Copper Company, E. R. Leach, president, 214 Hillside Avenue, Piedmont, California, has been the only important producer of copper in Trinity County. The property is at Island Mountain, a station on the Northwestern Pacific railroad, in the southwestern corner of the county, Sec. 9, 10, 15, T. 5 S., R. 6 E. In 1914, the property was said to contain 275,000 tons of proved ore, 3½% copper and 1½ ounces silver and $2.00 gold per ton in sulphides. A maximum of 1000 tons per month was being shipped to the smelter at Tacoma, Washington. This activity apparently ceased about 1918. The property was visited in 1939. It was idle and equipment was in a wrecked condition. Country rock is a sedimentary series, probably Franciscan.

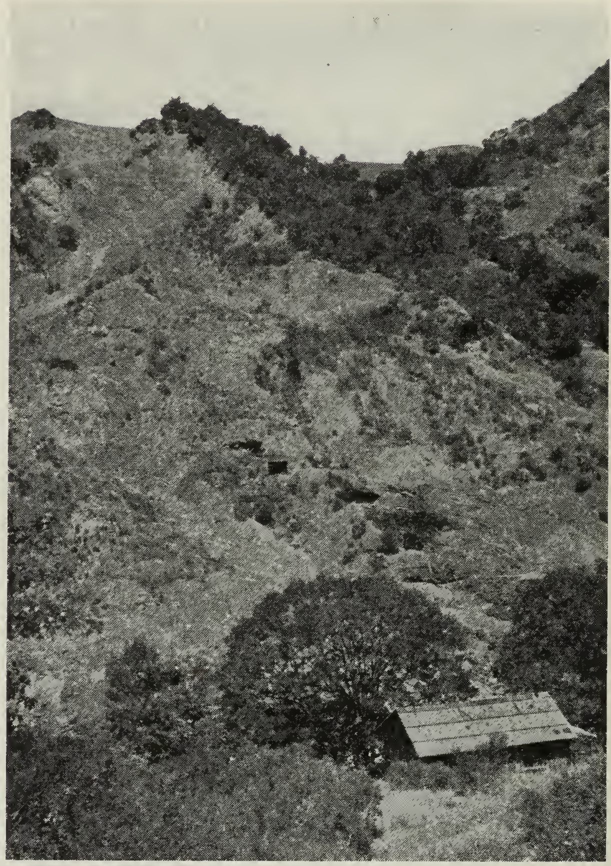

FIG. 1. Island Copper Company.

GOLD.

Outlines of the geology of the gold districts have been given under the general headings of geology and mineral resources above; also references to more detailed reports. A table of mines is given at the end of this report containing a comprehensive list of mines with references to reports in which descriptions of them may be found. Mines that have been active recently are described below:

Amy Balch Mine is a property of four unpatented claims in the Deadwood District, Sec. 13, T. 33 N., R. 8 W., owned by Milton G. Carter of Redding. Redding is 30 miles southeast by road, 18 miles of which is state highway. The remainder is the old Tom Green stage road climbing the mountain on fairly steep grades above French Gulch. Carter states that this mine has produced $35,000 or more from veins of ocher and quartz associated with the contact of diorite porphyry and Bragdon slate. In some places the veins cut through both of the formations mentioned. This production was made in 1913 and earlier, with hand tools, and the treatment was in arrastras. Widths varied from a few inches to a maximum of 8 ft., with an average of about 2 ft. These workings have since caved.

In 1939 the four claims were leased to Chas. D. Bates and others, c/o Bates and Borland, 1212 Broadway, Oakland, California. Work was being done under the supervision of D. W. Albert of Lewiston, who had a crew of three men. A new level was being driven on the Zent claim at an elevation of 50 ft. below the lowest of the old levels or 35 ft. above the creek. A crosscut runs south for 124 ft. to tap a vein consisting of gouge and crushed quartz. An east drift had been driven for 95 ft., exposing an average width of 2½ ft. of ore said to assay $4 to $15 in gold, average $7. Assays of more than $20 per ton were disregarded. The vein shows a maximum width of 5 ft. in the drift and 15 ft. in a short raise from the drift. A west drift had been driven for 95 ft., the first 25 ft. in ore, and a 25-ft. crosscut had been driven from it to the north. The vein is associated with the contact of diorite porphyry intruded into Bragdon slate. Some fine-grained, andesitic appearing rock is exposed in the crosscut also.

Bailey Claim of the old Globe mine, which was the important producer of the Dedrick region, in Sec. 15, 16, 21, T. 35 N., R. 10 W., is held by E. V. Reynolds of Dedrick. No. 2 level of the Globe, which was driven through the mountain from the Stuart Fork side to the Canyon Creek side, at an elevation about 500 ft. below the outcrop of the vein, passes through this claim. The tunnel is partly caved.

Bazet (Beaudry) Mine comprises several thousand acres of placer gravel near the old town of Minersville, Sec. 28, 29, 32, 33, T. 35 N., R. 8 W. It is owned by the estate of Angele Bazet, c/o Mrs. Marie B. La Porte, 4 Laguna Street, San Francisco. Some drilling and sampling have been done recently but no mining. Litigation with Nugget Bar Placers over water rights has been settled.

Bear Tooth Mine is an old mine in the New River District near Denny (formerly Quinby), T. 7 N., R. 7 E., H. M., described in Bulletin 50 of this division under the heading of copper claims. When it was visited, most of the workings were closed by caving, but a one-stamp mill and a small Huntington mill equipped with plates for amalgamation were still on the property. Sulphides on the dump appeared to contain a high percentage of arsenic with a little copper. Oxidized ore of the appearance of gossan from a vein 1 ft. to 2½ ft. in width had apparently been treated for its gold content.

Bergin Hydraulic Mine (Laws, Eldorado) comprises 550 acres of patented land in Sec. 18, T. 33 N., R. 10 W., and Sec. 12, 13, T. 33 N., R. 11 W., assessed to J. W. Bergin and Lena A. Bergin of Weaverville. It is about a mile up the Trinity River from the state highway at Junction City. Work during the season 1938-1939 was done by a group of lessees, all of Junction City: J. Castro, Frank Carr, Charles Carr, Harry Irvin, Lauren Gribble, and Earl Dawson.

The deposit consists of terrace gravel of Trinity River, and it is loose enough so that it is easy to mine and easy to wash. Bedrock is hornblende schist considerably decomposed so that much of it looks like serpentine. Mining is done from banks of gravel 30 ft. to 50 ft. high above bedrock with hydraulic giants. The terrace is high enough above the river (roughly 50 ft.) so that the tailing flows to Trinity River.

Water from three different creeks is collected in a reservoir. A ditch from Soldier Creek is 3½ miles long, 8 ft. wide in the bottom, and 3 ft. deep, and has a capacity of 4000 miner's inches. Mill Creek runs through the property and during a good season will supply 2000 miner's inches. McKinney Creek supplies about 250 miner's inches. From the reservoir to the pit is a line of 24-inch pipe, 1400 ft. in length. From this, 18-inch lines and 15-inch lines supply the giants. A head of 200 ft. is available. Equipment is said to have cost $200,000. During the season mentioned, water-supply was sufficient for eight hours of work per day in 2-hour stretches.

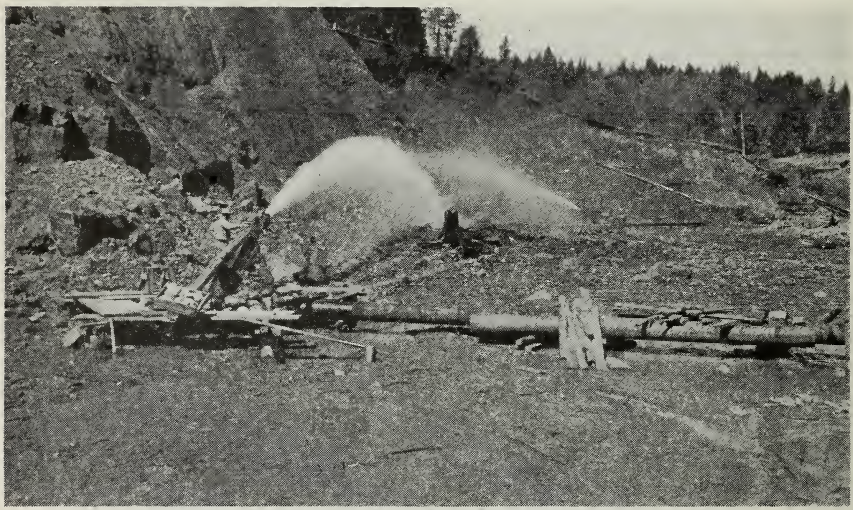

FIG. 2. Bergin Hydraulic Mine.

Four giants with 5-inch and 6-inch nozzle openings were set up, and 3½ acres of ground were worked to a depth of 30 ft. to 50 ft. Gold was recovered in a sluice of 12 boxes, each 12 ft. long, and set at a grade of 8½ inches in the 12 ft. Steel rails were used for riffles. In addition to gold, an ounce or a little more of platinum-group metals is recovered per season.

Black Cloud Group consists of nine unpatented lode claims in Sec. 31, 32, T. 34 N., R. 9 W., 2½ miles by road north of Weaverville. They are held by W. R. Bigelow, G. P. Jones, E. J. Stevens, F. L. Griffith, and R. S. Thompson, and are optioned to E. N. Todd, Weaverville.

The claims are on gentle slopes cut by small ravines. A metamorphosed sedimentary series with possibly some interbedded lava is intruded by fine-grained porphyritic dikes of more than one kind, some light in color, some dark. Only superficial surface cuts have been made, and they have not penetrated below the highly weathered and decomposed zone near the surface. Mica schist is the most prominent of the metamorphic series, but strata a few inches wide of slaty material and siliceous material are seen also. The whole is said to carry $4 to

$6 per ton in gold. This is based on three surface-samples taken by E. N. Todd, and a run of 40 tons treated in a small mill of the ball and ball-race type some years ago. An additional indication that the surface material contains substantial amounts of gold is that 'snipers' work it on a very small scale at times when storm-waters are available.

Bluejay is a property of four lode locations in Sec. 2, T. 33 N., R. 8 W., 30 miles northwest of Redding by mountain road, held by William Collins of Redding and Douglas City. It is developed by an 800-ft. adit, which is caved at the 400-ft. point. This develops a 3-inch to 4-inch quartz vein carying gold, on the contact of greenstone (probably Copley meta-andesite) and diorite porphyry. The strike is northeast, and the vein has a steep dip to the northwest. About five tons of ore were shipped from the mine in 1936. Since that time only assessment work has been done.

Brown Bear Mine has the largest production-record of the quartz mines of the county and of the Deadwood and French Gulch districts, which really form a single district separated only by the Trinity-Shasta county line. It includes 35 separate parcels of patented land assessed to E. E. Erich, French Gulch. Most of these are 20-acre lode claims, but a few larger tracts, placer claims and timber-land are included. They are in Sec. 11, 12, 13, 14, 16, 24, T. 33 N., R. 8 W., 30 miles by road from Redding, of which 18 miles is state highway, and most of the balance beyond French Gulch is winding dirt road with fairly steep grades. A longer route, via Lewiston, avoids some climbing, also avoids a summit, which is at times closed by winter snow.

Erich estimates past gross production at $8,000,000 to $10,000,000, and states that he has definite detailed records of more than $3,000,000 of this. Three of the individual orebodies are stated to have produced in excess of $1,000,000 each.

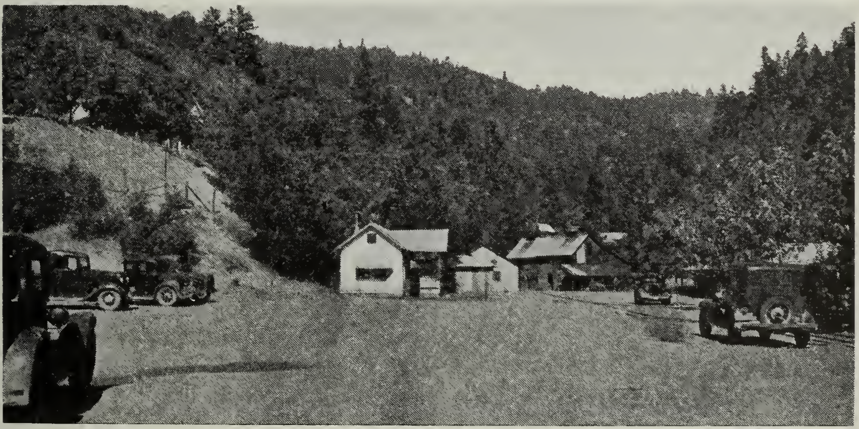

FIG. 3. Brown Bear Mine, Watt adit level.

A vertical section showing details of the formations and the occurrence of the ore has been published in California Journal of Mines and Geology, combined issue of January and April, 1933, copies of which are still available at offices of this division. A map showing areal geology of the region is included. The gold occurs in veins and fissures within a body of slate, which has been cut and intruded by porphyry masses and dikes. The principal rock is the Bragdon slate, which is found in two distinct types with some intermediate varieties. One of these is hard, siliceous, and blocky. The other is soft, black and graphitic. Intruded into the slate are the diorite-porphyry and the soda-granite-porphyry, which have been described in detail by Ferguson.[1] Extensive fissuring of all of these rocks has occurred, and it is along some of these fissures that gold-bearing solutions have passed, leaving traces and concentrations of gold. Some veins can be traced 1000 ft. to 3000 ft. They parallel and also cut the inclosing rocks at acute angles in both strike and dip. They pinch and swell abruptly. In the expansions of the veins the filling is usually quartz, and at the ends or contractions the filling becomes an admixture of quartz with slate or porphyry or both; and finally the vein pinches down to a gouge-filled fissure. Mineralized fissures cut through both slate and porphyry, usually carrying a few inches of quartz of a high assay value; but they are in many places not large enough to be mined at a profit except at intersections. The ore is white quartz carrying pyrite and sphalerite, a little galena and arsenopyrite, and free gold. The ore is usually of medium to high grade, varying from $10 to $1000 per ton in gold content. Sulphides amount to 1% to 4% of the ore. The veins strike in various directions but with a general east-west trend. There is a tendency to a reversal of dip on the lower levels, making the average dip nearly vertical. Principal production of the Brown Bear came from the Monte Cristo and Last Chance veins, explored for 2600 ft. along their strike, and extensively mined to a depth of 400 ft. Small portions of these veins have been mined to a depth of 760 ft. below the surface. Several smaller veins have been explored near the surface, and have produced important amounts of high-grade ore. Both the Monte Cristo and Last Chance veins are strong fissures with maximum widths of 20 ft.; but in places they contract to a few inches of gouge. Ore was mined to a maximum width of 20 ft. and averaged between $20 and $100 per ton. The gold is not uniformly distributed throughout the veins, large portions of which contain only lean gold values. The Watt tunnel, 350 ft. below the lowest of the old productive workings, has been driven more than 6000 ft., and has been kept in repair during recent years.

Mines Exploration Company acquired the Brown Bear mine on lease and option in 1939. It is a copartnership of F. E. Yoacum, 472 Vernon St., Oakland, California, C. C. White, Hotel Leamington, Oakland, and others. The mill was started on September 6 under supervision of E. A. S. Whittard, Deadwood, via Lewiston, with a crew of 10 men and a cook. The mill is of 75 tons rated daily capacity, and is a combination of the old mill of the Brown Bear and new machinery used for a short time at the American mine across the line in Shasta County. It includes 10 stamps, two small Marcy ball mills, classifier, Bendelari jig, three Fagergren and six Fahrenwald flotation cells, and clean-up pan. At time of our visit, it was being operated as a pilot-plant to determine what can be done with dump-ore. References to older reports on the Brown Bear mine are contained in the accompanying table of mines.

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[1] Ferguson, H. G., Gold lodes of the Weaverville quadrangle, California: U. S. Geol. Survey Bull. 540-A, pp. 16-73, 1913.

Buckeye Mining Company (Majestic, Humboldt, Pacific), of which Dr. R. C. Morris and Frank Thompson of Chico are officials, has leased from *Humboldt Placer Mining Company* 6700 acres of mining claims, mostly unpatented, in Sec. 2, 3, 4, 9, 10, 12, 13, 14, 15, 16, 21, 22, 24, T. 34 N., R. 9 W., Sec. 6, 7, 18, 19, 30, 31, T. 34 N., R. 8 W., Sec. 6, T. 33 N., R. 8 W. Half a dozen buildings erected by State Emergency Relief Administration, Transient Division, are in use. R. G. Percy of Minersville is in charge. Work completed in the spring of 1939 included the repair of two miles of the old Buckeye ditch and the construction of a mile of new ditch. Water-supply is taken from Tannery Gulch and Slate Creek. A new pit was started on a terrace of Tannery Gulch near its mouth, at an elevation of 75 ft. above Stuart Fork. Giants with 4-inch and 3-inch nozzle openings were operated for a short time under a head of 180 ft. Very little mining was possible during the season on account of shortage of water. This terrace is said to have been developed for a width of 300 ft. and a depth of 8 ft. for a distance of three-quarters of a mile. A portion of a higher terrace is said to have been developed by means of four drill-holes in 20 acres to a depth of 90 ft. to 100 ft. Bedrock is partly Tertiary gravel and partly Bragdon slate. Plans call for extending the ditch 12 miles to Van Matre Creek. See Majestic also.

Bully Choop Mine in Sec. 4, 5, 8, 9, T. 31 N., R. 8 W., adjoining the Cleveland mine on the Shasta-Trinity county-line was formerly held by Bully Choop Gold Mining and Power Company, 805 Atlanta Trust Building, Atlanta, Georgia. The patented land, about 200 acres, was deeded to the State of California for five years' delinquent taxes in 1931. Five of the unpatented claims were relocated by H. E. Upham and D. S. Upham of Douglas City. Details of elaborate machinery installed by the old company and of some of the old workings are given in California Journal of Mines and Geology, combined issue of January and April, 1933, copies of which are still available. In 1939, one man was prospecting on the property, Maurice Collins, Douglas City.

Canyon Placers, Inc., A. J. Brandt, president, A. H. Bowman, secretary, 416 Stormfeltz-Loveley Building, Detroit, Michigan, acquired the Grotefend, Dannenbrink, Clarke, and other properties amounting to a total of 1500 acres on Canyon Creek near Dedrick about 1933. The property is in Sec. 29, 30, 31, 32, T. 35 N., R. 10 W., Sec. 1, 12, 13, 24, T. 34 N., R. 11 W., Sec. 6, 7, 18, 19, T. 34 N., R. 10 W. At that time H. G. Kenworthy, general manager, and George H. Bergin, superintendent, were in charge of operations. The distance from Redding is 70 miles, 60 miles State highway to Junction City, balance dirt road up Canyon Creek, narrow and winding. The holdings are in two separate tracts, both covering terrace gravels of Canyon Creek and tributaries, one tract above Dedrick, the other below.

The company equipped the property with an elaborate water-system for hydraulic mining on the upper tract only. It has not been extended to reach the lower tract, which is dependent on small local gulches, Gwynn and Rarrick (Rarie), for water. Water-supply for the upper property included 100 cubic feet per second from main Canyon Creek and the entire flow of its East Fork. The system comprises 20,000 ft. of ditch and flume from Canyon Creek, with a capacity of 4000 miner's inches, and 6000 ft. of ditch and flume from the East Fork, capacity 2000 miner's inches, both feeding a 1,000,000-gallon reservoir. The main flume is partly 4 ft. wide with a grade of 20 ft. per mile, and partly 5 ft. wide with a grade of 10 ft. per mile. To cross some of the tributaries, inverted siphons were required, one 1300 ft. long of 40-inch pipe and one 900 ft. long of 30-inch pipe. From the reservoir, 2400 ft. of 30-inch pipe was laid to the hydraulic pit, giving an average head of about 300 ft. Equipment for the pit included five No. 6 giants with 7-inch nozzle openings, and 1500 ft. of 15-inch pipe. A Pelton wheel and 20-kw. generator were installed for electric lights.

A new camp at Dedrick includes three double houses, three houses to accommodate four men each, office, bath-house, garage, framing mill, blacksmith shop, water-supply and fire-protection system. Two miles of private road were built, and the entire road from Junction City up Canyon Creek was repaired, including the bridges.

In 1934, the company operated a pit on each of the two tracts. The one on the upper tract was mined practically continuously during the water-season, for 24 hours per day, with two giants with 7-inch nozzle-openings. On the lower tract, one giant with 7-inch nozzle-opening was operated three shifts each day, but water was available for mining only 2½ hours out of each 8 hours. The gravel, containing a few large boulders was mined from the surface down to the hard hornblende schist bedrock, in depths varying from a few feet to 75 ft. Gold was recovered in sluices equipped with wood-block riffles. Duty at the lower pit was 3.6 cubic yards per miner's inch per 24 hours, while that at the upper pit was 1.5 cubic yards. The difference was due to more compact gravel at the upper pit and to a greater thickness of fine overburden at the lower pit.

During recent years, the property has been leased to George H. Bergin of Dedrick, who is also local agent for the company. He has been working the lower tract with a crew of seven men working on two shifts. Maximum water-supply during the season 1938-1939 was sufficient to supply one giant with 7-inch nozzle-opening for only 6 hours out of 24 hours. The deposit being worked is an upper terrace of Canyon Creek, nearly 200 ft. higher than the present stream. A bank about 50 ft. in height is about half overburden, the balance being rather heavy gravel. Largest rocks are removed from the pit by means of a trolley running on an overhead cable. The water-system includes 1700 ft. of 30-inch pipe and 1600 ft. of 15-inch pipe. From Rarrick Gulch, a head of 260 ft. is available, and from Gwynn, a head of 325 ft.

Carrville Gold Company, Edward C. Condon, president, Harvey A. Grover, secretary, 807 Lonsdale Building, Duluth, Minnesota, owns a tract of land in Sec. 29, and has leased a number of tracts in Sec. 8, 17, 20, T. 37 N., R. 7 W., covering extensive gravel deposits on the Trinity River just upstream from the point where the old Estabrook dredge ceased operations. The distance from Redding is 53 miles over mountain roads, and from Trinity Center, it is three miles.

In 1939, Yuba Manufacturing Company built a modern steel dredge at practically the same location where the wreck of the old Estabrook dredge lies. The steel hull of the new dredge is 150 ft. by 68 ft. by 10 ft. deep, and the bucket-line contains buckets of 12 cu. ft. capacity running at a speed of 22 per minute. It is the largest dredge in the northern part of the state. Local business is handled by Yuba Consolidated Goldfields, for whom H. C. Perring is in charge of operations.

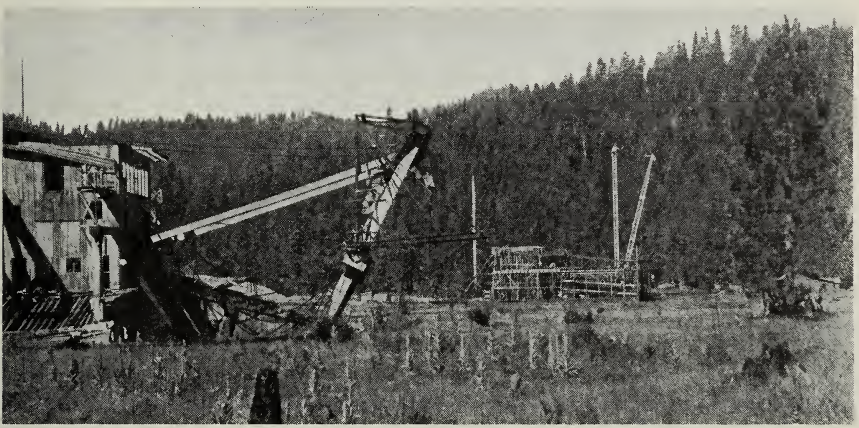

FIG. 4. Foreground—Estabrook Dredge, dismantled. Background—Carrville Gold Company, dredge under construction.

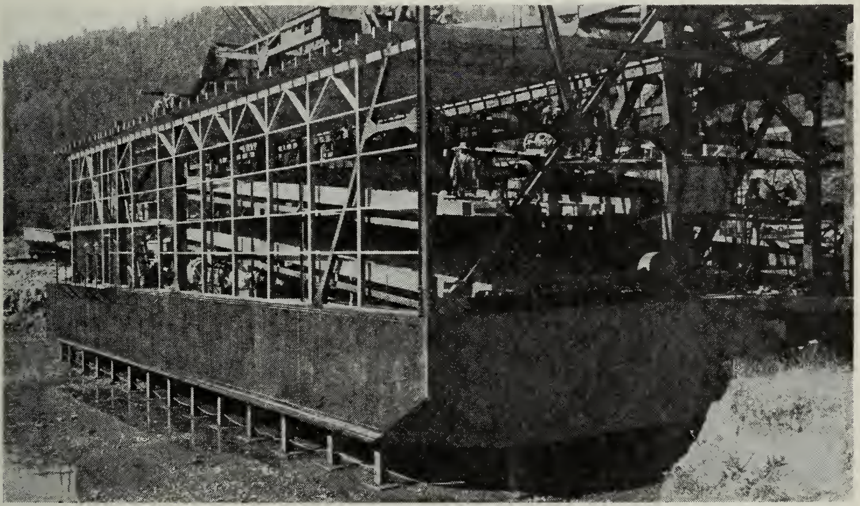

FIG. 5. Carrville Gold Company, details of dredge-construction.

Chloride is one of the claims of the old Globe mine (which see) near Dedrick, now held by Roy Rosenbush of Dedrick. Two men have been working old stope-fills with a small Huntington mill.

Cinco Mineros Company, C. E. Cummings, president, R. G. Stapleton, secretary, Box 212, Oroville, California, in 1939, was operating a dragline dredge of conventional design, similar to those described in some detail in our California Journal of Mines and Geology, April, 1938. The location is Sec. 7, 8, T. 31 N., R. 11 W., on the Hay Fork of Trinity River, two miles upstream from the point where Hayfork Gold Dredging Company worked. Redding is 67 miles east by hard-surfaced mountain road. A tract of 75 acres was to be dredged, practically all gravel on low bars at the confluence of Big Creek with the Hay Fork. The depth averaged about 10 feet, and the surface was only a few feet higher than the level of the Hay Fork. Some large boulders had to be laid aside by the dragline. Bedrock is volcanic tuff in various stages of decomposition, some soft, some fairly hard.

The dragline was a Lima with 60-ft. boom, 1½-cu. yd. bucket and diesel engine. Washing plant was of Bodinson make mounted on a wooden barge, 32 ft. by 42 ft., to the sides of which were attached two steel pontoons, each 3 ft. by 32 ft. Depth was 40 inches. Water for the pond was pumped from the Hay Fork with an 8-inch pump driven by an 8800 diesel engine of 65 hp. A D-13000 Caterpillar diesel engine drove the machinery on the barge. The crew of 15 men was in charge of L. Quint.

Coro Gold Mining Corporation, a Washington corporation, 19 Dover Green, Dover, Illinois, owns 160 acres of patented ground and mining claims to make up a total of 220 acres in Sec. 14, T. 36 N., R. 8 W., five miles west of Trinity Center. Redding is 60 miles southeast by mountain road. A deposit of gravel that appears to be similar to the Tertiary deposit of the Weaverville basin occurs here. It is irregular, probably due to local faulting. One shaft has been sunk 116 ft. without striking bedrock, while another went through the gravel at a depth of 60 ft. The gravel lies near the top of a ridge between two forks of Swift Creek, nearly 200 ft. higher than the nearest point on the main stream.

The gravel is mined by means of the hydraulic method with water from Swift Creek. A water-right of 2500 miner's inches is held. The supply is carried to the mine through 3½ miles of ditch and 6300 ft. of pipe of 32-inch size reduced in several stages to 15-inch in the pit. A head of 350 ft. is available. Work was started on March 23, 1939, with two giants with 6-inch nozzle openings. Difficulty was encountered with tough, compact strata of clay. H. H. Coffey of Trinity Center was in charge of the crew of 11 men.

Costa Mine is a patented property of 560 acres in Sec. 16, 17, 21, T. 34 N., R. 9 W., owned by Mrs. Jesse Costa of Weaverville. It covers parts of Rush Creek and terraces along it for a length of 1.4 miles. Hydraulic mining is carried on by Mrs. Costa's three sons. A water-right of 3000 miner's inches is held. Water for two giants with 4½-inch nozzle openings, amounting to 1000 miner's inches, is taken from Rush Creek through 1¼ miles of ditch; and each giant is supplied by a separate 15-inch pipe, 800 ft. in length, giving a head of 150 ft. A second ditch, a mile in length, supplies bank-water of 2000 miner's inches. In 1939, the hydraulic pit was on the first terrace, only a few feet above the present stream. Gravel was mined from a face 35 ft.

in height including 6 ft. to 7 ft. of overburden. Some large boulders were stacked by means of a dragline bucket and gasoline hoist. Bedrock is cemented Tertiary gravel. Gravel mined amounts to about 9000 cubic yards per year. A road running up Rush Creek from Lewiston passes through the property.

Dawn of Hope and Dutch Creek Groups are two groups of seven lode claims each held by Mrs. M. M. Knapp of Junction City and Redding, in Sec. 6, T. 32 N., R. 10 W. The distance from Redding is 68 miles, State highway for 59 miles from Redding to Junction City, balance rough one-way road up the west side of Trinity River. The last half-mile is trail. On the Dawn of Hope group, a vein from 6 inches to 18 inches wide, average about a foot, strikes southeast and northwest, and dips 45° to 60° northeast. It is exposed here and there by surface-cuts for a length of 500 ft. along the strike. A 40-ft. crosscut adit cuts it at a depth of 30 ft. below the surface, and 40 ft. of drifting has been done on the vein. Some stoping was done from this drift more than 30 years ago, and the ore was milled in a small cannon-ball mill that stood on the property, with results said to have been good. Country rock is a greenstone, probably the Copley meta-andesite. Some placer mining has been done in the slide-rock of the hillside with recovery of rough pieces of gold. A large body of quartz has been cut on the Dutch Creek group by a ditch-line. A crosscut of 150 ft. has been driven to this, and considerable $4-ore is stated to be indicated; but additional sampling is needed to confirm this.

Dorleska Mine is an old mine in Sec. 20, T. 37 N., R. 9 W., and is an extension to the north of the same system of lamprophyre dikes and veins that is found in the Yellow Rose mine, which is described in some detail in our Mining in California, issue of January, 1931. The Dorleska was equipped with a small 10-stamp mill, and has an estimated production of $200,000. The old workings are closed by caving. Some new development work has been done in recent years by Henry Carter of French Gulch and Redding. So far as known to the writer, no new ore has been discovered. The mine is near the headwaters of Coffee Creek at an elevation of more than 6500 ft.; and it is usually not accessible during winter and spring months.

Enterprise Mine is a group of 18 lode claims, of which three, the group knows as the *Yellowstone*, are patented. The location is Sec. 29, 32, T. 35 N., R. 11 W., at a distance of 75 miles west of Redding, mostly by state highway. The last six miles is mountain road, narrow and winding, following the East Fork of the North Fork of Trinity River. It is the property of Chiksan Oil Company, 401 Chapman Building, Fullerton, California, which company worked it for a period of about 10 years. R. H. Shaw was superintendent for a large part of that time. On November 1, 1938, operations were started by six lessees, Al Hansen, Earl Chapman, Joe Tuey, Jack Olson, Fred Smart and W. D. Chippey, all of Helena.

Flat quartz veins with dips of only 10° and an average width of 2 ft. occur in a greenstone, locally called diorite. It is more probably a metamorphosed andesite, although some dioritic material is intruded into it as narrow dikes. The quartz contains free gold, galena, sphalerite, pyrite, and some carbonate, probably ankerite.

From a level 147 ft. higher than the creek, the main vein has been stoped out for a length of 1600 ft. Some stoping has been done on a branch vein also. A level 75 ft. higher than the creek has been driven for a distance of 2000 ft., and the vein has been stoped out to the level above for a length of 350 ft. From this lower level, a winze has been sunk for 180 ft., and 100 ft. of crosscutting has been done at the 50-ft. level. The vein is disturbed by faulting in this winze.

The ten-stamp mill of 1200-lb. stamps has a capacity of 12 tons per 24 hours when grinding to 50 or 60-mesh. Lessees sort their ore to a grade of about $25 per ton. Most of their recovery is made on two amalgamation plates, each 4 ft. by 12 ft. A single flotation cell, 18 inches square, produces about four tons of concentrate per year assaying $300 to $400 per ton in gold. Other equipment includes an air compressor of 725 cfm. capacity driven by water power, and a second compressor of 525 cfm. driven by a diesel engine. Water to drive the larger compressor and the mill is taken from the East Fork through two miles of ditch. It is delivered at the mill through a 24-inch pipe at 60 lb. per square inch pressure. At time of visit in July, 1939, lessees had mined and milled 500 tons of ore.

Fairview Mine includes 440 acres of patented mining claims assessed to Fairview Mining Company, Room 1204 Russ Building, San Francisco, and additional unpatented claims. The location is Sec. 10, 11, T. 34 N., R. 8 W., on Trinity River, 10 miles north of Lewiston. From the road along the river, it is accessible by foot-bridge or by fording the river at times of low water. A steep mountain road connects the mine with Trinity Mountain Ranger Station, north of French Gulch. The mine has been worked at various times for many years, in 1901 to 1908 by the company, later by different groups of lessees.

In 1939 lessees were Don Matheson, W. Waldo, and H. W. Yokel. They were working on the east side of the mountain, the opposite side from the extensive workings driven by the company years ago. At the time of our visit, the adit was 285 ft. long and was said to be at an elevation between No. 1 and No. 2 levels of the old mine. In the face was exposed a 3-ft. stringer zone striking southerly and dipping 47° E. The hanging wall is Bragdon slate. The footwall is so silicified that it is difficult to name. Probably it is dioritic dike. In the mill were a 3½-ft. Huntington mill driven by a 6-hp. steam engine, and plates for amalgamation, 3 ft. by 10 ft.

French Bar Mining Company, F. A. Braman, president, Lee Nafzgar, secretary, W. F. McClure, manager, Del Loma, California, worked a gravel deposit of Trinity River, Sec. 29, 30, T. 5 N., R. 8 E., H. M., several years ago. The location is about half way between Redding and Eureka on the state highway. A tract of 80 acres was held.

The company mined in the bed of the river with a gasoline power shovel of one cubic yard capacity. A dam across the river, 250 ft. long, wooden crib and earth fill, diverted the water through a 500 ft. tunnel to expose the gravel for a length of 1800 ft. of the river-bed. This tunnel was driven nearly 50 years ago. The shovel worked in a pit 25 ft. deep, but bedrock had not yet been reached at the time of our visit. It was probably 6 ft. to 8 ft. deeper. Five ten-ton trucks were used, one hauling boulders, three hauling gravel from the shovel, and one spare. McClure stated that 800 cubic yards were handled per day of nine hours. The gravel was hauled for a distance of 1500 ft. up an incline from the shovel to a stationary washing plant, where it was dumped into a double grizzley. Large boulders, 20 inches and more in diameter, were discharged from the first grizzley to a dump. Boulders from 20 inches to 4 inches in diameter were rejected by the second grizzley, and were hauled to a waste-pile by a truck. Undersize was washed in a sluice, 22 inches wide and 120 feet long. Water amounting to 6 or 7 cubic ft. per second was taken from French Creek by means of a pipe varying from 15 to 18 inches in diameter. Total production by this method was stated to be $13,500 at a cost per cubic yard of gravel handled of 29 cents. Only a part of the deposit was worked.

Geneva-Trinity Mining Company, a partnership of R. F. Oliphant, L. W. Gretsch, H. M. Bruce, Fern Bruce, and Dan Bradley worked terrace gravels of Trinity River with a power shovel in 1935. A lease was held on 122 acres of the property of W. A. Pattison of Big Bar in Sec. 6, T. 33 N., R. 12 W. Gravel was excavated with a Bucyrus-Erie gasoline shovel of three-eighths of a cubic yard capacity, and was washed in a stationary sluice. A six-inch Fairbanks Morse pump and 35-hp. gasoline engine were used to pump water from the river for washing.

Globe Consolidated (see Bailey and Chloride also) is an old mine in Sec. 15, 16, 21, T. 35 N., R. 10 W., on the ridge between Canyon Creek and the Stuart Fork of Trinity River, at an altitude of 6100 to 6700 ft. No. 2 level, the main working tunnel, 1700 ft. long, was driven through the ridge from the Stuart Fork side to the Canyon Creek side. Mills were built on both sides of the ridge. On the Canyon Creek side, a 20-stamp mill with a cyanide plant of 100 tons daily capacity was completed in 1913. This was operated until 1918, but was dismantled in 1920, and little has been done with the property since that date.

The vein consisted of a series of quartz lenses in a zone of much-sheared hornblende schist, striking S. 55° to 70° W., with an average dip of 60° SE. It varied in width from 18 inches to 36 ft., and was mined for a width of 9 ft. to 10 ft. in several places. Dikes of diorite porphyry, alaskite porphyry, and soda granite porphyry are found nearby.

Four claims are now held by J. A. Gilzean and W. M. Gilzean of Junction City, the Globe, Brown Bear, Moonlight, and North Star. In 1937, the No. 3 adit level, 1700 ft. long, at an altitude 800 ft. below the outcrop of the vein and 300 ft. below No. 2 tunnel, was reopened. Some ore assaying $9.75 across a width of 9 ft., with gold figured at $20.67 per ounce, is said to be exposed. Two lessees have been working dump-ore with an arrastra. References to older reports on this mine are contained in the accompanying table of mines.

Golden Gravels Mining Company, Wm. C. Deal, president, 914 Hobart Building, San Francisco, is operating a dragline dredge on land leased from Geo. Herron, Junction City. It is a tract of 340 acres, of which about 100 acres is dredging-ground in Sec. 33, 34, T. 34 N., R. 11 W., on Trinity River near Helena. G. W. Hassler of

Helena is in charge. The dredge that was built for Gold Acres Dredging Company in Shasta County, equipped entirely with jigs[1] was used for a time, but later a new dredge equipped with riffles was built similar to those described in State Mineralogist's Report XXXIV, pp. 101-110. The dragline shovel is equipped with a bucket of 2½ cu. yd. capacity.

Golden Jubilee Mine is a group of 14 unpatented mining claims in Sec. 4, T. 37 N., R. 8 W., five miles northwest of Carrville, assessed to McCormick Saeltzer Company, c/o D. V. Saeltzer, Redding. A fissure vein discovered in 1892, is developed by seven adits with approximate altitudes as follows:

B	3700 ft.
A	3600 ft.
No. 1	3500 ft.
No. 2	3400 ft.
No. 3	3350 ft.
No. 4	3300 ft.
No. 5	3050 ft.

The strike of the vein is N. 20° E., and the dip is 75° to 85° east. From the upper levels, stopes have been driven with average widths of 3 ft. and maximum width of 8 ft. on white quartz containing free gold, pyrite, galena, and tellurides. The vein is associated with a lamprophyre dike intruded into granodiorite. This is described in some detail in our Mining in California, issue of January, 1931. Some difficulty seems to have been experienced in finding the vein on the lowest level; and very little stoping has been done from it. The mill of 10 stamps and an air compressor, 9 inches by 8 inches, are driven by water-power. The mine has been operated recently by *Trinity Gold Mines, Incorporated,* P. C. Stoess, president, Seattle, Washington. This company no longer holds it; and during 1939 it has been idle.

Golden King Group (Jumbo) is a group of three unpatented claims and a mill site, Gold King, Gold Queen and Nancy Lee, held by Nicholas Burkig, Weed; Fred Grooms, Weaverville; and Robert J. Coonrod, Montague. The group was being prospected a few years ago by Grooms and Chas. A. Mitchel of Lewiston. It is reached only by pack-trail. From Forks of Salmon, an 18-mile trail crosses the summit of the ridge to the south, at an elevation of 6500 ft., to reach the property near the source of Virgin Creek at an elevation of 4500 ft., in Sec. 28 (?), T. 9 N., R. 7 E., H. M. A trail of about equal length starts at Denny (Quinby) on New River. The quartz veins are said to have been discovered in 1884.

A quartz vein occurs on each of the claims. On the Nancy Lee the width is 6 inches to 8 inches; on the Golden Queen, 2½ ft. to 4 ft.; on the Gold King, 6 ft. to 25 ft. On the Gold King and the Golden Queen, the white quartz contains arsenopyrite. In most of the exposures the percentage is small, but a few concentrations occur. Delevopment work has been done at both ends of the Gold King claim. On one end is a 75-ft. crosscut to 6 ft. of quartz, on which a 15-ft. drift has been driven. On the other end a 50-ft. crosscut reaches 7½ ft. of quartz, with a 50-ft. drift. The Golden Queen has been developed through a vertical distance of 190 ft. by four adits at different altitudes. The lowest of these is the longest and comprises a 135-ft. crosscut and 30 ft. of drifting on a 2½ ft. vein. One sample taken here by the writer and one at the east end of the Gold King indicate that the gold-content of the quartz is small. Development on the Nancy Lee consists of two open cuts 4 ft. to 5 ft. in depth.

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[1] Averill, C. V., Mines and mineral resources of Shasta County: Calif. State Mineralogist's Report XXXV, pp. 135-137, 1939.

Little, H. S., Gold Acres to operate jig dredge: Mining & Industrial News, San Francisco, issue of May 15, 1938.

Goldfield Consolidated Mines Company has purchased the Jacobs property and has an option on the Red Hill property in Sec. 1, 2, T. 33 N., R. 11 W., Sec. 35, 36, T. 34 N., R. 11 W. The area is several hundred acres. This property was formerly held by Northern California Mines Company (which see). Geo. Wingfield is president of Goldfield Consolidated, and Willis A. Swan is secretary, 1225 Crocker First National Bank Building, San Francisco.

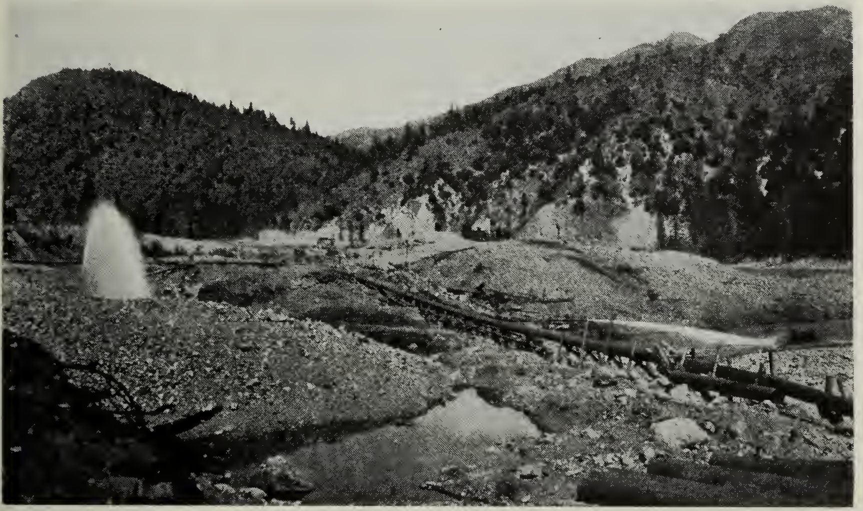

FIG. 6. Goldfield Consolidated Mines Company.

In 1939, two leases were in effect, one held by J. A. Gilzean of Junction City, the other by Gilzean Brothers of the same place. J. A. Gilzean, with a crew of nine men, operated a hydraulic pit near river level. A 52-ft. face of gravel was mined at the rate of 1500 cubic yards per 24 hours. About 2000 miner's inches of water are available for 24 hours per day from Canyon Creek, but this was collected in reservoirs to make a larger supply available for two working shifts. Water is carried across Trinity River in 1500 ft. of 28-inch pipe, part of which is on a suspension bridge. A second line on this bridge designed to carry water from a higher ditch is not in use. For mining, 2600 ft. of 24-inch and 18-inch pipe were in use to supply the giants. Two No. 6 giants with 6-inch and 7-inch nozzle-openings were used for mining, and one No. 4 giant with 5-inch nozzle-opening for stacking tailing. Head of water on the giants was 246 ft. Bedrock is hornblende schist.

Warren Gilzean, with a crew of three men, operated a pit 375 ft. above river-level with water from Conner Creek. A deposit with a depth of 120 ft., of which 12 ft. is gravel and the balance overburden, has an area of about five acres. Due to shortage of water in the season 1938-1939, not much mining was possible in this upper pit.

Grand National Mining Company, c/o A. F. Stone, manager, Callahan, California, holds a tract of 240 acres of patented land in Sec. 25, T. 39 N., R. 8 W., on Parker Creek, a tributary of Tangle Blue Creek. Gazelle is 43 miles northeast by mountain road with dirt surface. The last five miles near the mine is steep and rough. A tractor with trailer is used for hauling concentrates and supplies over this stretch. The elevation is 5300 ft.

The main adit level is a drift following a 4-ft. quartz vein in an easterly direction for 700 ft. It then strikes a north-south shear-zone, which, in 1937, was being mined for its gold content. The shear-zone is 23 ft. in width and dips 70° E. One shrinkage stope was being driven, 100 ft. long, 15 ft. wide, with face 60 ft. above the main adit level. Country rock is granodiorite. Drifts on the main adit level, on the shear-zone, had a total length of 300 ft. In the portion of this drift to the north, the hanging wall of the shear-zone is formed by a black, fine-grained basic rock. A 100-ft. crosscut had been run into this rock, and it was said to assay in gold throughout, as much as $3.50 per ton. Apparently this same basic rock had been injected along the planes of shear in the granodiorite to form the ore-body being mined. The ore-body contained also much shattered white quartz containing pyrite. At the south end of the workings, a 1-ft. quartz vein had been followed into the hanging wall of the shear-zone in an easterly direction for a distance of 100 ft. Both quartz veins have vertical dips. The adit taps the shear-zone at a depth of 400 ft. below the surface. A 50-ft. winze sunk below the adit-level, on the shear-zone, was full of water at the time of our visit. A short shoot of good ore was stoped from this to the main level.

Ore was treated in a mill containing Blake crusher, 5 by 8½ inches, five-stamp battery, ball bill 4 ft. by 3 ft., classifier, and five flotation cells: three Denver Sub-A and two Fagergren. Grinding was to 60-mesh and capacity, 30 tons per 24 hours, making a ton of concentrate. A 47-hp. Caterpillar diesel engine furnished the power. Mine equipment included a compressor and machine-drills. The property was idle during 1939.

Gunther Group comprises 19 placer locations in Sec. 36, T. 31 N., R. 11 W., held by E. J. Gunther of Hayfork and others, at the confluence of the East Fork with the Hayfork of Trinity River. The group was leased in 1939 to E. N. Sewell of Gridley, California, who installed one of the portable gold washing plants manufactured by Judson-Pacific Company, 609 Mission Street, San Francisco. The company issues literature describing the outfit. The machinery is similar to that used on dragline dredges, but it is mounted on caterpillar tracks and wheels instead of a barge. A hopper, trommel, and belt-stacker for coarse tailing are provided, and either jigs, sluices, or bowls may be installed for recovering the gold. Four electric motors, two of 5-hp. each, one of 10-hp., and one of 25-hp., drive the machinery. Sewell's outfit was equipped with four Ainlay centrifugal bowls, each about three feet in diameter. They are provided with riffles around the circumference inside, and are rotated so that centrifugal force causes the heavier material to travel toward these riffles, where concentration is effected. The lighter material and water overflow to a launder around the edge of the bowl. Gravel was excavated with a P. & H. dragline and a one-cubic-yard Page bucket. Water was pumped from a pond below the outfit by a 60-hp. tractor engine through 1000 ft. of 8-inch pipe. The outfit was idle at the time of our visit. Tailing piles indicated that several thousand cubic yards of gravel had been treated.

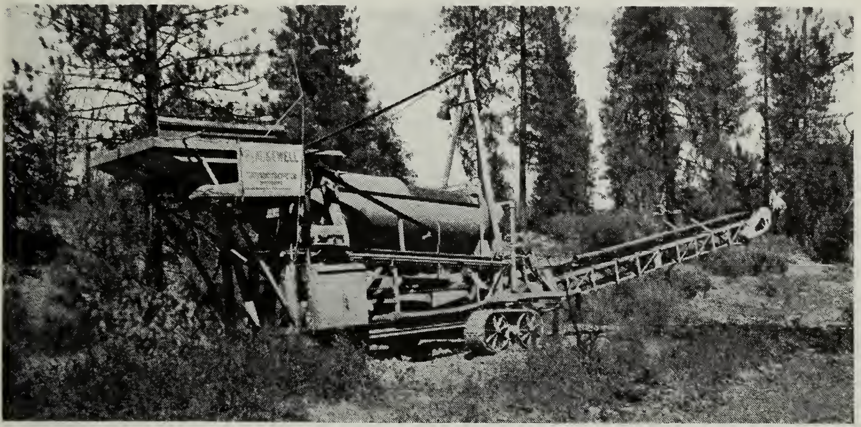

FIG. 7. Gunther Group, dry-land dredge.

Gypsie Queen (Gold Standard) is a property of 80 acres in Sec. 23, T. 38 N., R. 9 W., 2½ miles by trail north of the road on Coffee Creek. Some development work has been done on a quartz vein, which the owners state contains substantial amounts of gold. It is owned by Leone Conant and others of Redding. The property has not been visited.

Hayfork Gold Dredging Company, Charles C. Stearns manager, Hayfork, California, operated a dragline dredge on Hay Fork of Trinity River, in Sec. 12, T. 31 N., R. 12 W. This has been described in our California Juornal of Mines and Geology, issue of April, 1938. Later the outfit was moved to Browns Creek, and gravel was dredged from bars of that creek in Sec. 30, T. 32 N., R. 9 W. It was then moved to property on Indian Creek held by the estate of Dr. D. B. Fields in Sec. 26, T. 32 N., R. 9 W., where it was idle during most of 1939. Analyses of three shipments of platinum group metals, of about 15 ounces each, produced near Hayfork, follow:

Platinum	24.2%	24.6%	19.76%
Iridium	28.3	27.0	35.35
Rhodium	.3	.5	Tr
Osmium	28.5	27.6	25.63
Ruthenium	12.	11.1	8.35
	93.3%	90.8%	89.09%

The remainder to make up 100% in each case was sand which had not been removed before the metal was shipped, and perhaps a little gold. The figures represent actual recoveries by refiners.

Hayward Hydraulic Mines include a tract of 80 acres in Sec. 30, T. 5 N., R. 8 E., and Sec. 25, T. 5 N., R. 7 E., H. M., covering terrace gravels of Trinity River This tract is assessed to the estate of Carrie Hayward, Big Bar. The deposits of gravel on terraces apparently continue on adjoining tracts; and the possibility has been considered of combining several of these to make a large hydraulic mine. Water would be taken from French Creek. At the time of our visit, equipment to make this water available had not been installed, and only small-scale mining was in progress.

Heninger Mine is a hydraulic mine in the bed of Coffee Creek in Sec. 25, 34, 35, T. 38 N., R. 9 W., operated by Heninger Bros. of Carrville. An un-named gulch supplies water for one giant with 2-inch nozzle opening under a head of 250 ft. Pipe is 15-inch. Very heavy boulders weighing many tons must be handled. A high cable-line and a hoist are provided for this purpose. Coarse gold is produced. A cut 200 ft. by 100 ft. by 20 ft. deep was excavated during the season 1938-1939, mostly in overburden. Three men were working.

Henry Clay is a single patented claim in Sec. 11, T. 33 N., R. 8 W., adjoining the Brown Bear property, owned by H. R. Anderson, c/o M. M. Getz, Flood Building, San Francisco. Adit levels, 250 ft. long and 400 ft. long, have been driven on a 4-ft. quartz vein, and some production was made years ago. The workings are in a dike of diorite-porphyry intruded into Bragdon slate.

Humboldt Placer Mining Company. See Buckeye Mining Company.

Indian Creek Mine. See Hayfork Gold Dredging Company.

Interstate Mines, Inc. operated a dragline dredge on a bar of Trinity River known as Poker Bar in Sec. 28, T. 33 N., R. 9 W., during 1939. E. B. Noble is president and J. C. Hamilton is secretary-manager, Box 498, Chico, California. A. B. Ogilvie of Weaverville is superintendent. Plans called for the dredging of 2,250,000 cubic yards of gravel from Poker Bar and another bar about a mile farther up the river, which had already been worked out at the time of our visit. Depth of the deposit at Poker bar varied from 10 ft. to 23 ft. Several feet of sand overburden were being removed from a part of it. The outfit included a Lima dragline of 3 cu. yd. size, on which a 2½-yd. bucket was being used; also a Bodinson washing-plant of a rated capacity of 3500 cu. yd. per 24 hours. This method of dredging has been described in detail in our California Journal of Mines and Geology, issue of April, 1938.

Junction City Mining Company started a modern steel bucket-ladder dredge in Sec. 18 and adjoining sections, T. 33 N., R. 10 W., near Junction City, on January 10, 1936, and has been operating continuously since that time. The company controls eight miles of the river, the lower (northerly) end of the property being in Sec. 1, T. 33

N., R. 11 W. Harvey Sorensen, 685 6th Street, San Francisco, is president; C. M. Derby, Mills Tower, San Francisco, is consulting engineer; and D. B. Wilson is superintendent at Junction City.

The hull of the dredge is new and of the late pontoon design, being no. 113 of Yuba Manufacturing Company. Transportation over mountain roads was one reason for adopting this design. The hull is 120 ft. by 52 ft. by 8 ft. 1 inch deep, and is made of 31 pontoons. These are designed and arranged so that the inside walls strengthen the hull at critical points. The largest pontoon weighs 24,000 lb. and the smallest 4800 lb. Most of them weigh from 10,000 to 16,000 lb. When assembled they form a rigid structure due to the beam-effect of the side-walls. Some of the machinery from the old Madrona dredge was used.

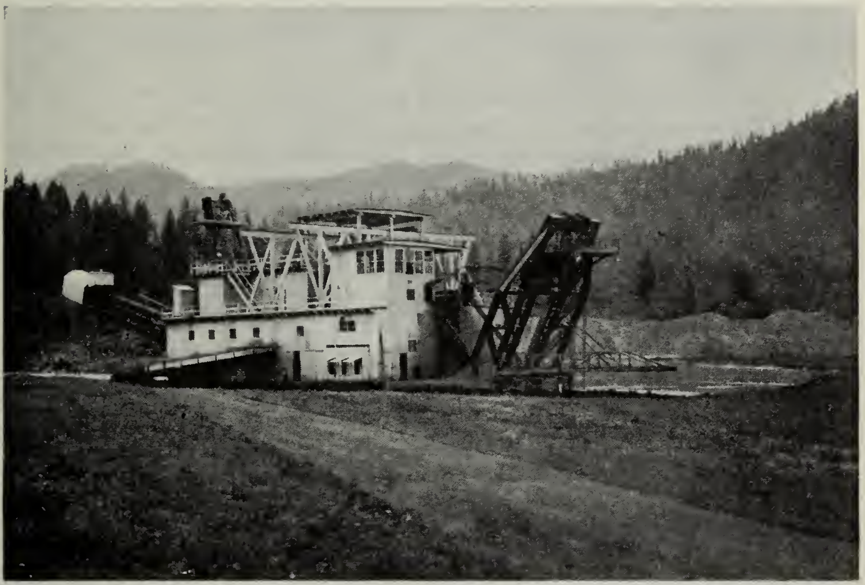

FIG. 8. Dredge of Junction City Mining Company.

The bucket-chain contains 79 buckets of 9½-cu.-ft. capacity each, and the dredge is capable of digging to a depth of 45 ft. below waterline. A maximum depth of 58 ft. has been reached by carrying part of the gravel as bank. Average depth of dredging is 28 ft. Bedrock varies from soft to hard but is decomposed enough so that a few inches of it can be taken up. The dredge is held in digging position by a single spud of 32 tons. The trommel is 7 ft. in diameter and is perforated with ⅜-inch to ½-inch holes, but one section of 2-inch mesh is provided for recovery of nuggets. Riffles are of the Hungarian dredge type shod on top with ⅛-inch strap iron. The stacker for coarse tailing is 135 ft. long and carries a 36-inch belt. The operating crew averages 24 men.

Electric motors are as follows: 50 hp. on a high-pressure 10-inch pump, 50 hp. on a low-pressure 10-inch pump, 50 hp. on an auxiliary

10-inch pump, 25 hp. on a 4-inch pump, 35 hp. on the winch, 35 hp. on the screen, 50 hp. on the stacker, and a 200-hp. digging motor.

The following figures on operation are furnished through the courtesy of C. M. Derby, consulting engineer. For the fiscal year ending June, 1937, the operating cost under rather severe conditions averaged 4.98 cents per cubic yard. This includes labor, material, power, ordinary taxes, and general expense. No land-cost, no royalty, and no depreciation are included. The average monthly yardage was 240,000 cu. yd. The approximate cost of the dredge was $250,000.

When the dredge was operated near the old Chapman mine, recovery of platinum group metals was as high as two ounces per week, and pieces as large as one-half ounce were recovered. In other locations the recovery was about one-half ounce per week. Analysis of a shipment follows: waste or sand, 38%; gold, 1.89%; platinum, 25.78%; iridium, 10.51%; osmium, 16.21%; ruthenium, 7.71%; palladium, 0.27%. Recovery of platinum from sands removed from the riffles at time of clean-up is made on a long tom on the dredge. The last cleaning is done by panning; and before the last panning, the concentrate is ground in a small ball mill and then is allowed to stand over night in nitric acid. Among the minerals contained in the concentrate is native cinnabar. The richest sand is found, and the poorest recovery is made in passing through ground that has already been mined. The channel of the river was mined shortly after 1850 in the days of the gold-rush. A dime that looked new, which carried the date 1838, was recently recovered.

Kelly Mine is a group of 11 unpatented lode claims located in 1932 and later years by T. C. Kelly of Hayfork. The location is in Sec. 20(?), T. 31 N., R. 11 W., at an elevation of 3735 ft. by aneroid, four miles southeast of Hayfork by dirt road, one and one-half miles of which is steep. Redding is 71 miles east; and the road from Redding to Hayfork is hard-surfaced.

A dike of very fine grain, light gray to dark gray in color, without visible original quartz, intrudes a series of cherts and slates with practically vertical dip. The dike dips steeply also, but the dip is not uniform in all exposures. Flat quartz stringers occur in the dike. They vary in width from a few inches to 14 inches; but a zone of such stringers may reach a width of several feet, maximum seven feet. The white quartz contains free gold, pyrite, arsenopyrite, galena, and probably some chalcopyrite. Some of it is stated to contain $1000 per ton in gold.

On the main adit-level, the dike has been followed in a southerly direction for 600 ft. Its width is roughly 20 ft. Some ore has been mined from flat quartz stringers on this level. At the time of our visit a raise was being driven to the level above. Later in 1939, Kelly brought to Redding a chunk of retorted amalgam weighing 130 ounces, which he stated was the free gold extracted from 11 tons of run-of-mine ore taken from a 30-ft. drift on a flat vein at an altitude of 30 ft. above the main level. The vein varies from 6 inches to 2 ft. in width. On a second adit-level, 80 ft. higher, the dike has been followed in a southerly direction for 185 ft. This includes a 60-ft. winze driven on a quartz stringer-zone at the south end, at an angle below horizontal of 20°. The zone is 7 ft. in width here. The new raise from the level below is placed to connect at this point. There is also a 60-ft. raise to the surface; and from this stoping has been done on horizontal quartz stringers. Sulphides are found in the dike at a distance from quartz stringers, and assays indicate that these contain some gold. A campaign of sampling to determine whether the entire dike will yield a commercial grade of ore is planned.

Equipment includes a Rix compressor, 6 by 6 inches, driven by a 15-hp. Fairbanks Morse engine of the Z type burning stove oil. The mill contains a gyratory crusher, 3½ft. Huntington mill, amalgamation-plate, 4 ft. by 6 ft., and tables covered with English corduroy. Power is furnished by a 15-hp. Fairbanks Morse diesel engine. On the corduroy a concentrate is produced at the rate of 25 lb. per ton of ore treated, which is stated to assay $600 to $800 per ton. The final tailing is said to assay $32 to $40 per ton and is being saved for further treatment.

La Grange Placer Mines, Ltd., c/o Estate of Dr. Lyman Stookey, Weaverville, is the present owner of the thousands of acres of land on which the famous La Grange mine is located. Hydraulic mining on a very large scale was carried on here for many years. The mine was located in 1851, incorporated in 1874, and worked by various companies until 1918. The location is Sec. 3, 5, 8, 9, 10, 15, 16, 21, 22, 26, T. 33 N., R. 10 W., three miles west of Weaverville.

The gravel-deposit is apparently a fault-block of the Tertiary (probably Eocene) gravels of the Weaverville basin. The limit of the hydraulic pit on the northwest is a distinct fault striking N. 64° E. and dipping 22° SE. Below the fault is greenstone or Copley meta-andesite. Above the fault, in the upper part of the pit, are the strata of gravel dipping toward the fault; while in the lower part of the pit, the underlying Bragdon slate is exposed.

During the period when the property was operated on a large scale, water was supplied through 29 miles of ditch and flume, of which 11 miles was flume of truncated V-shape, nine feet wide on top, two feet wide at the bottom, and five feet deep. Capacity was 3500 miner's inches, and the grade was 10 ft. per mile. Water was taken from Stuarts Fork, Rush Creek, and Weaver Creek. This system comprising ditch, flume, inverted siphons, and a tunnel at Stuarts Fork is now in a wrecked condition. A second water-system consisting of 12 miles of ditch, flume, and 30-inch pipe, taking water from East Weaver Creek and West Weaver Creek, is still in usable condition.

In 1932, the California highway commission authorized the construction of a state highway from Weaverville to Junction City. The division of highways adopted a route through the La Grange mine. In order to lower the grade and shorten the distance, it was decided to make a great cut through the La Grange property, involving the excavation of more than 6,000,000 cubic yards of gravel and underlying slate. The water system from East and West Weaver Creeks was leased for the purpose of making this excavation by the hydraulic method. The ditch and flume were repaired, and a 600,000 cu. ft. reservoir was built. Giants were operated intermittently as this reservoir filled. Time between runs was, of course, governed by the supply of water entering the reservoir, which varied from more than the capacity of the ditch and flume, 55 cubic feet per second, down to only a few cubic feet per second. Of many similar runs made, the following is selected as representing roughly average conditions: elevation of giant, 2921 ft.; nozzle-opening, 8 inches; head of water, 529 ft.; average discharge, cubic feet per second, 44.3; average velocity, feet per second, 127; pipe, 978 ft. of 30-inch, 416 ft. of 26-inch, 146 ft. of 22-inch, 849 ft. of 18-inch; hours worked, 179.6; approximate cubic yards excavated, 322,000; cubic feet of water used 27,786,000; duty, 24 cubic yards per miner's inch per 24 hours; cubic yards per hour, 1790; cost per cubic yard, 2.5 cents; distance to bank, 200 ft.; height of bank, 100 ft.; type of material, medium, crushed slate and large gravel. This gives a good idea of what can be done when the hydraulic method is used for excavation only. However, the mud discharged was so thick that little chance would have been afforded gold to settle out of it, and the gold miner would either have to cut down the yardage handled or provide a supply of 'bank-water' to dilute the mud.

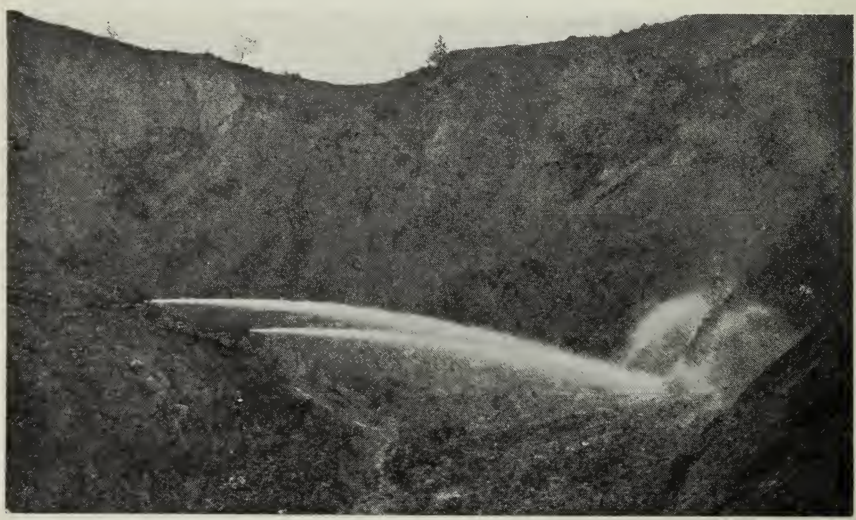

FIG. 9. La Grange Mine, work of State Division of Highways. The streams of water are about 150 feet in length.

Until 1939, when the excavation was nearly finished, no effort was made to save gold. Some experiments were made during the year by La Grange Placer Mines, Ltd., with Vincent Ryan of Weaverville in charge, in the recovery of gold with jigs. A part of the flow of mud was diverted through a sluice equipped with an undercurrent to pass sizes of $\frac{1}{4}$-inch and less through a screen. The flow was to two Bodinson-Heath rougher jigs, and concentrate was cleaned in two cleaner jigs of the same make. Rubber diaphragms in the lower part of these jigs are actuated by oil-cylinders. Pressure was supplied by a pump driven by a gasoline engine. At the time of our visit, a few tons of concentrate had been accumulated.

The company is said to be planning to resume operations as soon as the highway-cut is finished, and the water-supply is available for mining.

Lary Mine is a property of two unpatented mining claims and a fraction near the Brown Bear mine, in Sec. 11, T. 33 N., R. 8 W., held by E. L. McConnell and others, Box 152, Castella. A 60-ft. upper tunnel and surface cuts expose quartz stringers, a few inches in width, containing free gold, and considerable pyrite and galena, associated with dikes from a foot to a few feet wide of a fine-grained porphyry (probably andesitic) intruded into the black Bragdon slates. A larger dike of coaser grain, in which the workings of the Henry Clay mine are driven, is said to be 100 ft. ahead of the face of this tunnel. Another tunnel, 50 ft. lower, has been driven 146 ft. entirely in the black slate.

Lewiston Gold Dredging Company is a new company formed to take over the Gold Bar dredge at Lewiston. It should not be confused with Lewiston Dredging Co., which formerly operated a dredge farther up the Trinity River at Minersville. The new company is a partnership of 13 persons, of whom three are general partners, Elwyn W. Stebbins, F. J. Estep, and C. H. Thurman, manager, 960 Russ Building, San Francisco. W. J. Harvey is superintendent at Lewiston.

The location is Sec. 18, 19, T. 33 N., R. 8 W. The present operations started in June, 1937, and it was planned to work from Lewiston down the river for two miles. The work is on an upper terrace. A new revolving screen and other new parts were installed on the dredge, and the hull was extended by means of steel pontoons.

The Gold Bar dredge was described in State Mineralogist's Report XXIX. The original hull was 79 ft. by 44 ft. by 7 ft. The dredge carried a chain of 45 buckets of 8 cu. ft. capacity each, which would reach a depth of 31 ft. below water line. It was held in position by headlines of 1½-inch steel cable. No spuds were used. Electric motors were as follows: 150-hp. digging motor, 30-hp. on 8-inch pump, 50-hp. on 10-inch pressure pump and 40-hp. on seven-drum winch.

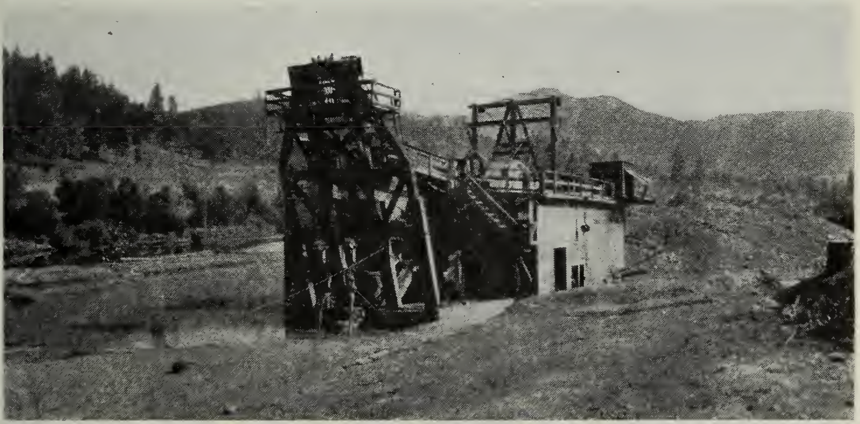

FIG. 10. Lewiston Gold Dredging Company.

Lincoln Gold Dredging Company is a partnership of E. M. Clark, French Gulch, and W. K. Jensen, Lincoln, California. Late in 1939, a dragline dredge was installed on a tract of 60 acres held by leases, covering bars on Trinity River, at a point four miles west of Lewiston, in Sec. 27(?), T. 33 N., R. 9 W. It was planned to dredge this tract to a depth of 6 ft. to 23 ft. The washing-plant is similar to those made by Bodinson, which have been described in some detail in our California Journal of Mines and Geology, issue of April, 1938, but it is of Clark's own make. It has a capacity of 3500 cu. yd. per day, and is driven by a D-13000 Caterpillar diesel engine. A 25-kw. electric generator is provided for lights and for one or two small motors as needed. Main drive is from engine to countershaft by multiple V-belt.

Several improvements on older designs have been incorporated. Disc-wheels, 36 inches in diameter, are attached to hand-winches instead of cranks. This is a safety measure to prevent the breaking of the operator's arm by a sudden strain which might reverse the direction of rotation of the crank. Beneath the trommel is the usual depressed trough containing baffles to regulate the flow of sand and water to each sluice. In each compartment of this, beneath the surface of the fluid, a jet of water supplied from a manifold impinges against a horizontal plate. Thus the contents of each compartment are kept in a state of agitation, giving the gold a chance to settle out. Clark says that most of his gold is recovered in these traps, and that it is not necessary to clean up the sluices so often. Sluices are equipped entirely with expanded metal lath over coconut matting, no riffles. Near the trommel a few strips of plate for amalgamation (silvered copper), 1½ inches wide and as long as the width of the sluice, are placed beneath the expanded metal lath. The pump-screen is in the form of a revolving drum to keep it free of floating trash. Several gates made of heavy steel bars, placed above the tailing stacker, are arranged to open upward only. Boulders traveling up the belt in the normal way pass through readily; but if a round boulder starts to roll bock down the belt, it is stopped by one of the gates, and is given a new start in the

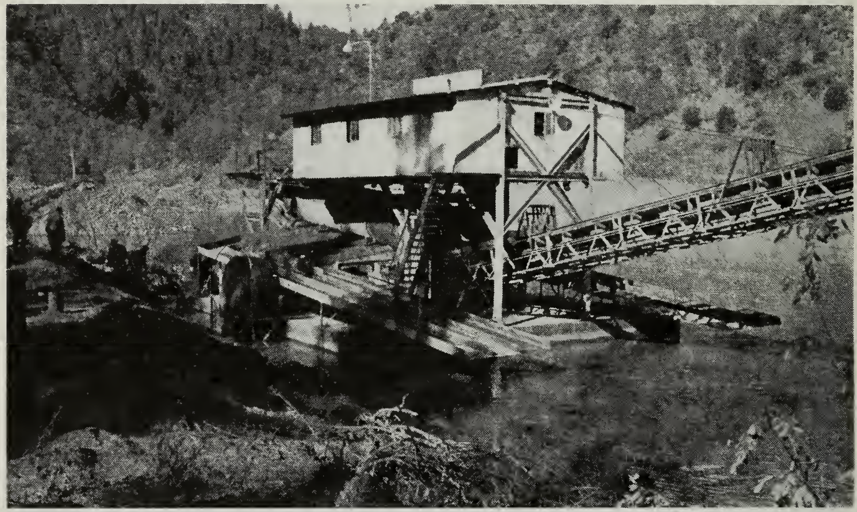

FIG. 11. Lincoln Gold Dredging Company.

proper direction. The dragline is a model 85 Northwest with a bucket of 2 cu. yd. capacity. The outfit includes also a Caterpillar tractor equipped with bulldozer.

Majestic Mines Company (Buckeye, Humboldt, Pacific) did some work on this property of thousands of acres of unpatented placer claims on the Buckeye Ridge between Stuart Fork of Trinity River and Rush Creek, near Minersville. One of the older names is now in use again, and recent work is described in this report under the name Buckeye Mining Company. The claims cover terraces of present streams and a large volume of Tertiary gravels similar to those of the Weaverville basin.

In 1935, State Emergency Relief Administration, transient division, leased 8000 acres of this land. A camp of frame buildings to house 250 men was built. Workers were to receive $5 per month plus board and lodging plus a share of the gold production made. The old Buckeye ditch was to be rebuilt to provide water for working gravels of Tannery Gulch and Slate Creek, two tributaries of Stuart Fork. Gold production was to be shared approximately equally between the workers and the relief-agency; and it was hoped that the project would become self-supporting. H. G. Thiele was in charge. After the camp was built, the project was abandoned. The buildings are now in use by Buckeye Mining Company, which see.

Maple is a quartz claim in Sec. 28(?), T. 35 N., R. 10 W., held by William Clarke of Weaverville. It is on the opposite side of the creek from the Mason and Thayer mine. The township has not been subdivided into sections. The owner working alone makes some production of gold at times. The claim was not being worked at the time of our visit to the district.

Marcellus Group of five unpatented claims in Sec. 32(?), T. 38 N., R. 9 W., on Union Creek, is held by F. A. Marcellus of Hanford. The mine is at an elevation of 6000 ft., and is reached by 15 miles of very rough and steep mountain road from Carrville. The last mile is trail. Mine address is Big Flat.

Three parallel dikes, each about 25 ft. in width, strike a little east of north. They differ somewhat in grain, and are apparently dioritic and andesitic. They intrude a mica-schist containing gray limestone in small lenses. Small veinlets, from a fraction of an inch to several inches in width, run from the westerly contact of the dike and the schist in an easterly direction into the dike. This particular dike is andesitic in appearance. A drift, 120 ft. in length, has been run along the contact on the west side of the dike in a southerly direction. The contact is marked by gouge formed from the schist, which probably indicates faulting. Dip is nearly vertical. The veinlets, which have been followed into the dike for a maximum of only a few feet, contain quartz, calcite, pyrite, and free gold. Carefully selected ore is treated in a W. W. Gibson eliptical roll mill with a rated capacity of 2 tons in 24 hours. Gold is recovered on corduroy. Water for power to operate the mill is brought in through 1100 ft. of ditch, then through fire-hose to give a head of 100 ft. at the mill. Two men work during the summer months only.

McClaren Group includes 12 unpatented lode claims in Sec. 10, T. 35 N., R. 11 W., six miles by trail north of the end of the road at the Yellowstone property of Chiksan Oil Company (see Enterprise). The owner states that four veins have been discovered on the property. On the Trinity group of three claims, adits have been driven both ways from the creek on a 1½-ft. quartz vein, for distances of 350 ft. and 150 ft. A winze has been sunk from each adit to depths of 42 ft. and 31 ft. The 300-ft. adit is said to expose 2 ft. of ore in the face, and the 150-ft. adit to be in ore for about 90 ft. In the summer of 1939, the owner was starting with a crew of three men to mine the ore and to treat it in a ball mill of 9 tons rated daily capacity. He was making concentrate on a table of the Wilfley type for shipment. No gold was recovered by amalgamation. The ore is stated to carry 1% to 2% sulphides. Concentrate must be packed on animals for the six miles between the mine and the end of the road. The owner is W. J. McClaren of Helena.

Mekel-Fields Property comprises three lode claims, Lone Star, Klondike, and General Lee, and one-half interest in the Hay Press placer, held by A. C. Meckel, Weaverville, and the estate of Dr. D. B. Fields. It is in Sec. 15, 21, T. 34 N., R. 10 W., on the south slope of Weaver Bally mountain, and is reached by four miles of trail from the end of the road. A raise from a 230-ft. adit level, at an elevation of 5810 ft., is said to expose 18 inches of ore assaying $37 per ton in gold, with gold figured at $20.67 per ounce. J. J. Jackson of Weaverville holds the group under lease and option, and keeps up the assessment work in connection with his work on the adjoining Patillo group, which see. Workings on the Mekel-Fields property have caved.

Mines Exploration Company—see Brown Bear.

Modoc Gold Mines, Inc., (Wagner) John H. Dequer, president and manager, J. C. Schneider, secretary, Farmers and Mechanics Building, Sacramento, operated property on Coffee Creek a few years ago, now assessed to E. A. Wagner, Carrville, M. W. Schmidt and P. W. Hamilton. The property included 240 acres of patented land and five unpatented mining claims in Sec. 34, T. 38 N., R. 8 W., and Sec. 3, T. 37 N., R. 8 W. Redding is 66 miles southeast mostly by mountain road. The camp was 2400 ft. north of Coffee Creek and 920 ft. higher in altitude.

Granodiorite has been intruded by lamprophrye dikes, and a mass of serpentine is found a few hundred feet to the north. Quartz veins occur in the granodiorite. A vein with an average width of 2 ft. and a maximum of 5 ft., which pinches in places to a gouge-seam, strikes N. 30° E. and dips 70° E. It had been developed by drifts of 150 ft. on an upper adit level and 550 ft. on the mill-level. The two drifts were connected by a 57-ft. raise. Ore-shoots were said to be 30 ft. to 60 ft. long and 2 ft. wide.

A mill was built containing a Straub crusher, 15-ton Straub ball mill, and 11 cyanide tanks with a total capacity of 178 tons of water. They included two Devereaux agitators, three Vandercook thickeners, one sump tank, one solution stock tank, one filter tank, one precipitating tank, and two mercuric-generating tanks. An oil engine furnished the power. Other equipment included a 75-cu. ft. portable type compressor driven by a gasoline engine, machine drills, assay office, bunk house, cook house, and a sawmill of 3500 board feet capacity in 8 hours. The equipment was used for only a short time.

Molitor Mine is a small hydraulic mine on Grizzly Creek, Sec. 33, T. 37 N., R. 11 W., owned by Farnsworth Brothers of Cecilville. It is about 10 miles by trail north of the end of the road at the confluence of Whites Creek and North Fork of Trinity River, and about the same distance by trail from Cecilville in Siskiyou County. Two men operate the mine with water from Grizzly Creek, using a 4-inch nozzle under a head of 100 ft. Bedrock is hornblende schist.

Mountain Boomer is an old quartz mine in Sec 19(?), T. 37 N., R. 12 W., 20 miles by trail north of the end of the present road at Quinby (Denny P. O.). State Mineralogist's Report X, 1890, states that it was equipped with a three-stamp mill of 450-lb. stamps at that time. In 1914 it had been developed by six levels varying in length from 60 ft. to 700 ft. on a 2-ft. quartz vein. Hundreds of feet of crosscutting had been done also.

Four claims are now held by Ladd Bros. of Denny. F. C. Meckel of Junction City leased the property in 1939. He states that the vein strikes easterly and westerly and dips 60° north. The lowest of the old levels was known as the Clement level, and a 16-inch width of ore was mined from it in the years 1909 and 1910. Meckel drove a 300-ft. crosscut adit at an altitude 100 ft. lower. He struck a 1-ft. quartz vein, but has not yet drifted to the pay-shoot, which rakes to the west. In 1914 the mine was estimated to have produced $350,000. The old workings developed the vein for a depth of 400 ft. on the dip.

Mueller Mine (Layman) includes the Gold Hill, Gold Hill No. 1, Oversight Fraction, Black Bess, Black Bess Extension, San Jose, San Jose Extension, and Red Boy, unpatented lode claims which have been surveyed, and 15 additional unpatented claims. They are in Sec. 20, T. 31 N., R. 11 W., 73 miles west of Redding by road, of which 67 miles, Redding to Hayfork is oiled mountain road, remainder dirt road. The owner is the Mueller Estate, O. R. Mueller, Administrator, Hayfork. Lon Layman of Hayfork owns one-half interest in six of the claims. Fissure veins carrying quartz, gouge, free gold and sluphides occur in a series of slates and cherts. For years the mine was worked on and off by the late Dr. Mueller of Redding. During recent years some work has been done under several different options.

The main adit level is on the Gold Hill claim, with portal at elevation of 3200 ft. The length is 400 ft., of which 320 ft. is on the vein. This consists of a mixture of gouge, crushed quartz and crushed country rock in a series of slates and cherts. In this adit, the hanging wall is usually chert, and the footwall is slate. The strike is northwesterly, and the dip is 46° northeast. The average width is 4 ft., and the maximum is 12 ft. O. R. Mueller states that the average gold content is $7 per ton, of which one-third is free gold, and the balance is in the sulphides. Two raises have been driven on the vein to the surface, of which the longer measures 140 ft. on the dip of the vein. A shoot of ore of better grade than average was partly mined out by this raise.

From the next gulch to the north, Star Gulch, an adit that will give 500 ft. of additional backs can be driven.

In 1939, work was being done by O. R. Mueller and Lon Layman on a cross vein about a quarter of a mile to the southeast. It strikes east and west and dips 70° south. A crosscut adit strikes the vein at a point roughly 50 ft. below the surface; and about 50 ft. of drifting has been done on the vein. It consists of strands of quartz to make up a width of 16 inches and is said to contain free gold to the amount of $30 to $50 per ton. A few tons had been mined at the time of our visit, and were to be run through the mill. Several hundred feet of adits have been driven on similar cross-veins on the southerly end of the property. The Kelly mine adjoins to the north.

The mill contains 10 stamps, of which five weigh 750 lb. each, and five weigh 1250 lb. each. Treatment is amalgamation on plates, which are followed by four Kraut flotation cells, each 36 inches square. A gasoline engine furnishes the power. Present water supply is small, but a better supply is said to be available in Star Gulch.

Nash Mine of 866 acres of patented ground covers Coffee Creek for roughly eight miles from Deacon Creek, a tributary the mouth of which is in Sec. 27, T. 38 N., R. 9 W., to the source of Coffee Creek in Sec. 7, T. 37 N., R. 9 W. It is assessed to E. S. Joseph, H. Goldberg, and E. Krischer, 182 Commonwealth Avenue, San Francisco. The lower part of the tract is in narrow strips following the creek; the upper part is wider. A tract of 150 acres from Deacon Creek to Adams Creek is leased to J. H. Gribble, Santa Cruz. Redding is 71 miles southeast by mountain road with the exception of 20 miles of highway. The last 15 miles up Coffee Creek is rough and steep.

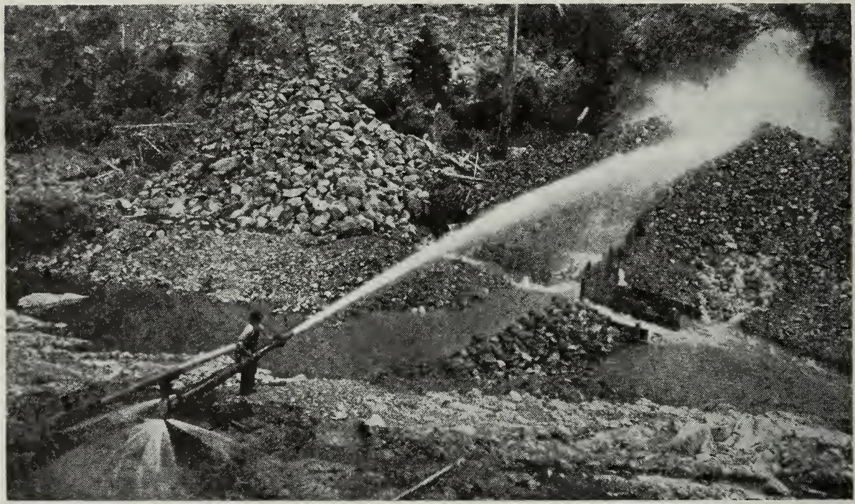

FIG. 12. Nash Mine.

In 1939, Gribble's lease was being worked by T. E. Himle, Carrville, and a crew of five to six men, by means of a hydraulic pit in Sec. 34, T. 38 N., R. 9 W. A reservoir on Hickory Creek is fed by both Hickory and Hardscrabble creeks, giving a head of water of 160 ft. at the mine. Pipe from reservoir to mine amounts to 1800 ft. of 22-inch and 20-inch pipe. The ditch carries water enough to supply a 4-inch nozzle and a 5-inch nozzle. During storms another 4-inch nozzle can be added. Shortage of water during the season 1938-1939 cut operations to part-time, as time had to be allowed for the reservoir to fill.

Gravels of the present channel of Coffee Creek were being worked to widths of 100 ft. and 200 ft. and a depth of 10 ft. Bedrock is rough serpentine. On account of the low grade of the stream in this locality, amounting to 2% to 3%, and the lack of low ground for dumping tailing, an elevator is used. This is an inclined grizzley made of steel rails with the base up. The spacng is $\frac{5}{8}$-inch, and all gravel larger than this is driven up the grizzley with the giants to a tailing-stack. This amounts to 70% to 80% of the gravel handled. Undersize drops to a sluice 3 ft. wide by 28 inches deep by 20 ft. long. It is equipped with steel rails for riffles, and is set on a grade of $1\frac{1}{2}$ inches to 12 ft. Large boulders are lifted on a high cable-line with a gasoline hoist. Gravel handled per season amounts to 30,000 to 35,000 cubic yards.

New River Mining and Development Company installed equipment a few years ago to work gravels of New River near Quinby (Denny P. O.) in Sec. 27(?), T. 7 N., R. 7 E., by hydraulic mining. At the time of our visit, a 7000-ft. flume was under construction to supply 3000 miner's inches of water from New River for washing the gravel. For mining with giants, a separate supply was to be brought in from Quinby Creek under a head of 150 ft.

Niedra Group of 12 unpatented lode claims in Sec. 33, T. 38 N., R. 9 W., is held by R. C. Norton of Carrville. Altitude is 5000 ft. Redding is 72 miles southeast mostly by mountain road. Diorite dikes intrude Abrams mica schist and serpentine; and gold is said to occur in the schist near the intrusive contacts. Overburden is heavy, and several cuts have been washed through it by ground-sluicing. They are 100 to 200 ft. long by 40 ft. wide and 20 ft. deep. Water for this purpose is taken from a small tributary of Union Creek through a 600-ft. ditch and a 300-ft. ditch, which feed a small reservoir, 12 ft. deep. When full, the reservoir discharges in 30 minutes through an outlet one foot square. Some gold has been recovered in riffle-sluices from this work. At the time of our visit in 1939, a crew of five men was starting work. Plans called for driving a tunnel in one of the exposures of Abrams mica schist.

Northern California Mines Company equipped a property near Junction City for operation as a large hydraulic mine and operated it for a time in 1934. The property was formerly known as the Red Hills mine and the Jacobs estate. The location is in Sec. 1, 2, T. 33 N., R. 11 W., and Sec. 35, 36, T. 34 N., R. 11 W., one to two miles below Junction City, on the opposite side of Trinity River. A strip, two miles long and about three-quarters of a mile wide, along the southwest side of the river was controlled. It is mostly patented land, and is now assessed to Goldfield Consolidated Mines Company (which see) and to J. Lindeberg, c/o Northern California Mines Company, 1225 Crocker First National Bank Building, San Francisco. The distance from Redding is 60 miles, state highway to Junction City, then dirt road on the opposite side of the river. W. C. Van Antwerp was president and W. J. Renz was secretary of Northern California Mines Company, 156 Montgomery Street, San Francisco.

The company built a new suspension bridge across Trinity River to carry water from Canyon Creek in two different lines at different pressures. The high-pressure line, 34 inches in diameter, carried water leased from Pacific Gas and Electric Company. This water is ordinarily used to operate a power house owned by Pacific Gas and Electric Co. The line included 3400 ft. of 34-inch pipe, then 3400 ft. of 30-inch pipe to reach a reservoir 370 ft. higher in altitude than the river on the opposite side from Canyon Creek. The reservoir covered 18 acres to an average depth of 8 ft. The low-pressure line, 28 inches in diameter, carried water from Canyon Creek, the right to which was owned by the mining company, through a ditch called the McGilvery. The line included included 1750 ft. of 28-inch pipe, then 500 ft. of 24-inch pipe to reach a pit near river-level. Two 18-inch branches were used in the pit. A second pit, in which the high-pressure was used, was 100 ft. higher in altitude. During the water-season, 1500 miner's inches of additional water was available for use in the sluices. In the lower pit, two giants with 5-inch and 6-inch nozzle openings were used for mining, and one with 4-inch nozzle for stacking tailing. In the upper pit, three giants with 6-inch nozzles were used. Gravel mined in the upper pit amounted to about 5000 cubic yards per day, and in the lower pit to 2500 cubic yards.

In 1939, the high-pressure water was no longer in use. Mining was being done near river level by lessees. Their operations are described herein under the heading of Goldfield Consolidated Mines Company.

North Fork Placers, W. P. Anderson, president, Ferro-Concrete Construction Company, Cincinnati, Ohio, R. L. Chase, superintendent, equipped a property at Helena for operation as a large-scale hydraulic mine, a few years ago. Patented land of 146 acres and unpatented land of 390 acres in Sec. 29, 30, 31, 32, T. 34 N., R. 11 W., were controlled. The land is now assessed to W. P. Anderson and R. L. Chase, c/o H. G. Schlomer, Helena, California.

A flume was built along North Fork of Trinity River, 40 inches by 31 inches by 12.8 miles long, on a grade of 10.56 ft. per mile to discharge water at a point 700 ft. higher in altitude than the river at Helena. An electric generator of 25-kw. capacity was driven by a 30-inch Pelton wheel supplied with water through a 6-inch pipe under a head of 337 ft. for lights.

In 1939, high terraces of Trinity River, 200 ft. to 300 ft. higher than the present stream were being mined under a lease held by H. G. Schlomer. Bryan Hinter was in charge of a crew of two men on each of three shifts. A second crew of the same size was installing a slack-line-cable-excavator of ½-cubic yard capacity to mine a river-bar. The terraces, which are located a mile to two miles west of Helena, have been cut into short segments and covered with overburden by erosion. Banks up to 50 ft. in height were worked with a single giant with 5-inch nozzle opening. Gold was recovered in sluices, 36 ft. long by 5 ft. wide, equipped with rails for riffles. Sizes below half-inch passed through a screen to two undercurrents, 12 ft. by 3 ft., set side by side, and equipped with Hungarian riffles.

North Star, Evening Star, and two other unpatented claims in Sec. 17(?), 20, T. 38 N., R. 6 W., on Mumbo Creek, are held by C. R. Estes of Alturas. In 1939, a crew of five men was working to equip the property as a small-scale hydraulic mine. A mile of new road had been built up Mumbo Creek. Castella is 28 miles east by road, which crosses a summit at an altitude of 5600 ft. Lumber was being hauled to build 1200 ft. of flume to supply a single giant with a 2-inch nozzle-opening. Pipe varying from 6 inches to 16 inches in diameter was to be installed for a length of 800 ft. from the flume to the mine, giving a head of 200 ft. Gravels along Mumbo Creek and bars 100 ft. in width and 12 ft. to 15 ft. deep were to be worked. Numerous large boulders were to be hoisted out.

At a distance of a mile and one-half farther up the Creek, Estes holds an option on property held by M. B. Cooley, Chester Hess, and Ernest Hess, all of Alturas, and three other persons. Seven samples from a dike are said to have given an average assay of $4.90 per ton in gold. The exposure is said to be one-quarter of a mile square. The ore contains arsenic, and is not free-milling. Some rich pockets have been found in quartz and ocher stringers.

Pansy Placer is a small hydraulic mine in Sec. 14, T. 36 N., R. 8 W., four miles west of Trinity Center, held by N. S. Dysert of Trinity Center. About 5000 cubic yards of gravel are mined in a season.

Patillo Property comprises three lode claims, Montezuma, Snow Shoe, and San Miguel, and one-half interest in the Hay Press placer, held by the estate of Emma A. Miller. The location is in Sec. 15, 21, T. 34 N., R. 10 W., high on the slope of Weaver Bally. The distance from Weaverville is 12 miles, of which about half is trail. J. J. Jackson, Weaverville, holds a lease and option on this as well as the adjoining Meckel-Fields property.

Prospecting on the Patillo is described in State Mineralogist's Report XXII for 1926. Since that report was written, a 228-ft. adit level has been driven, of which 114 ft. was drifting, giving backs of 120 ft. measured on the dip of the vein. The vein has been stoped out to the surface. From this work, C. E. Rice is said to have milled 400 tons of $18-ore, from which he recovered $12 per ton by amalgamation in a small Huntington mill. Jackson is driving a level at an altitude 120 ft. lower. It includes a 165-ft crosscut and 48 ft. of drifting. He states that 18 inches of quartz assays $4.62 per ton in gold. This vein, which is on the Montezuma claim, strikes northerly and southerly and dips 45° west. It is said to be the same vein as that on the Meckel-Fields property, and to have been traced for a length of one and one-half miles on the surface.

Paymaster Mine is in Sec. 2, T. 33 N., R. 8 W., 33 miles northwest of Redding by road, half mountain road and half state highway. Two separate groups of claims are held under option by Leroy Kerr of Yolo and Schilling, California. One of the groups is the property of the estate of P. X. Johnson, Bank of America N. T. & S. A., Administrator, Redding; and the group comprises the Bingo and Jumbo lode claims and the Old Hickey and Old Hickey No. 1 placer claims. The other group is the property of William Richards, Clara M. Richards, and Deda J. Paulsen of Lewiston, who have granted an option to Chenoweth & Leininger of Redding, and they have given an option to Kerr. The group comprises the Readjuster, Buffalo, Eagle Bird, and Minnie May lode claims, and the Paymaster mill site.

In 1939, Kerr was working the property with one other man, Fred McMullen of Schilling. New work was being done in an old adit consisting of a 150-ft crosscut and several hundred feet of drifting both ways from the crosscut on a vein showing an 18-inch width of gouge and ocher with occasional bunches of quartz carrying considerable gold. The vein strikes N. 65° E., and has a nearly vertical dip. Old work had included the stoping this vein for a length of 300 ft. to 400 ft. to a level 90 ft. above. New work was intended to locate extensions of the orebody. The vein is on the contact of a 25-ft. diorite porphyry dike intruded into Copley meta-andesite. Development work, mostly raising, had yielded 30 to 40 tons of ore at the time of our visit. Production from this was stated to be 12 ounces of gold.

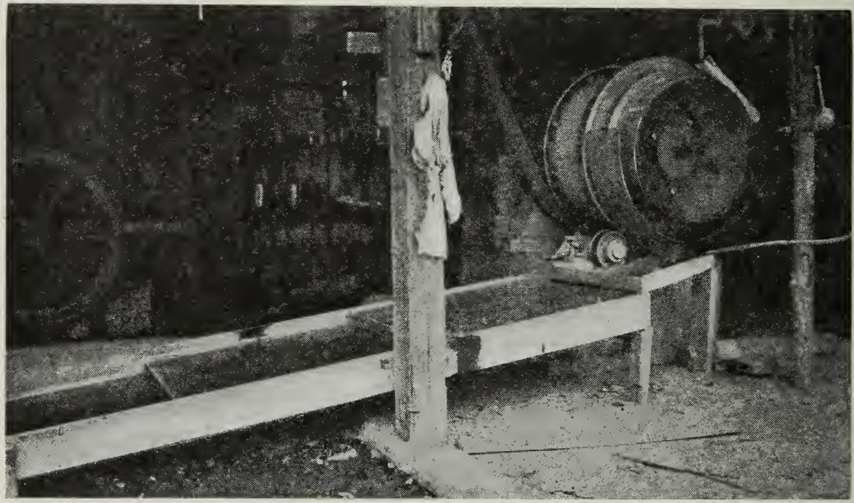

FIG. 13. Mill at Paymaster Mine.

The mill included a crusher and a 2-ft. by 3-ft. ball mill with a rated capacity of 15 tons per day. Pulp from the ball mill passed over three amalgamation-plates each four feet square, then to a small jig, then to two amalgamation-plates, each three feet square. A Wilfley table in the mill was not in use. Power was furnished by an oil-engine.

Placer Development Company, c/o Bodinson Manufacturing Company, 2401 Bayshore Boulevard, San Francisco, was installing a dragline dredge in Sec. 1, T. 33 N., R. 11 W., at Junction City, late in 1939. The plan was to work up Canyon Creek for a distance of one and one-half miles, with a 50-B Bucyrus dragline designed for a 3-cu.-yd. bucket, but equipped with one of 2½ yards capacity. The washing plant is the only one equipped entirely with jigs in northern California. It was originally manufactured for Gold Acres Dredging Company for use in Shasta County, and is described in some detail in our recent report on that county in California Journal of Mines and Geology, issue of April, 1939. It has been described in greater detail by H. S. Little.[1]

Poor Boy is a promising prospect, four miles by trail south of Big Bar, held by Geo. C. Cottrell of Big Bar. A quartz vein, 2 ft. to 4 ft. in width, strikes northerly and southerly, and dips 45° west. It is developed by surface cuts, 100 ft. apart, for a distance of 400 ft., and has been traced for several hundred feet more along the strike. Samples believed to be reliable, taken in the cuts, indicate a gold content as high as $34 per ton. Others were $12.60 and $9.80, with several around $3. Additional work may result in the development of an oreshoot.

Rainbow is a group of four unpatented claims in Sec. 32, T. 32 N., R. 8 W., 15 miles southeast of Douglas City by steep mountain road, held by Mrs. L. L. Kelley of Fresno. A flat quartz vein, nearly parallel to the hillside, shows a few inches to 2 ft. of white, sugary quartz. Gold weathered from this is found in the overburden. Two men, P. H. Smith and N. A. W. Smith, have been working this overburden with a hydraulic giant with 2-inch or 3-inch nozzle during the water season. During the dry season, they search the exposed bedrock for seams, and work the product in a Gibson mill.

Ralston Mine is an old mine, which has been described in State Mineralogist's Report XIV for 1913-1914. At that time it was said to have produced $40,000 in gold. It has been relocated with a total of six claims by F. C. Meckel and G. W. Cordes of Junction City. The property is in Sec. 32, T. 35 N., R. 10 W., one and one-half miles southeast of Dedrick by steep mountain trail.

Cordes and one other miner, working with hand tools, drifted for 120 ft. on the vein, and raised for 100 ft. The vein strikes southwest and northeast, dips 45° southeast, and has a width of from 18 inches to 2 ft. The work exposed some good ore consisting of white quartz with about 5% of pyrite and chalcopyrite. The ore is partly oxidized; and ocher bands have been formed from the sulphides, thus setting free part of the gold. A shipment of 7½ tons of picked ore, sorted from roughly 80 tons run-of-mine, was shipped to the Selby smelter, and gave net smelter returns of $2,230. Later a two-stamp mill of stamps weighing 1000 lb. each was installed. Amalgamation was the only treatment. Additional ore was run through this to make the recent total production $18,000.

Salmon Summit Mine is on the high, inaccessible divide between Trinity and Siskiyou counties at an altitude of more than 6000 ft. The best route is from the north; and the distance from Gazelle or Yreka is about 85 miles, mostly mountain road. The last 15 miles is steep mountain trail. Two claims, Redfield and Salmon Summit are held by Theodore Richardson, 243 Grant Street, Eureka, in Sec. 23(?), T. 9 N., R. 7 E., H. M.

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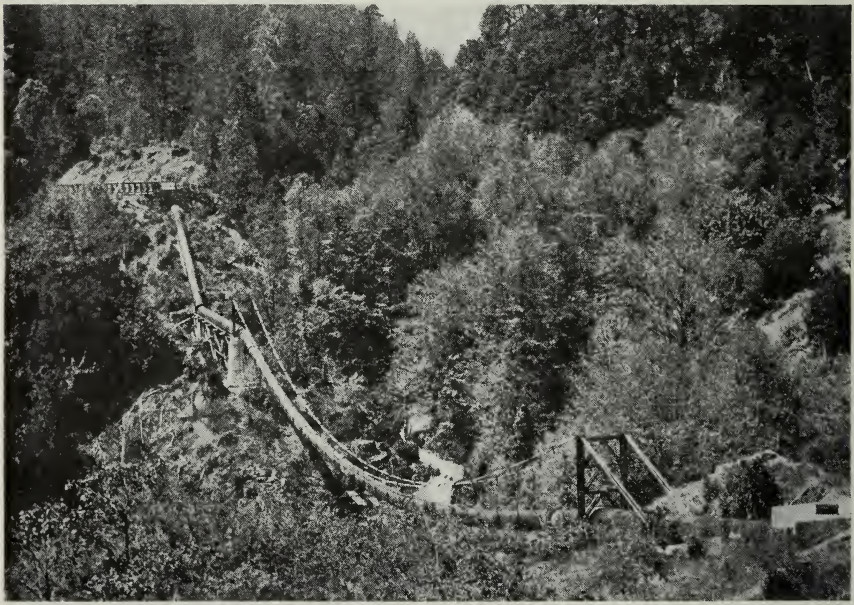
[1] Little, H. S., Gold Acres to operate jig dredge: Mining and Industrial News, San Francisco, vol. 6, no. 5, p. 6, May 15, 1938.

A 50-ft. adit on the Redfield claim cuts a 5-ft. to 6-ft. shear-zone containing lenses of quartz and iron sulphides with free gold. The strike is northeast and southwest, and the dip is 30° SE. The lenses are 6 inches wide and 6 ft. long. A picked piece is said to have assayed $120 per ton. On the Salmon Summit claim, a 50-ft. crosscut tunnel cuts a one-foot quartz vein, which strikes northeast and southwest, and dips 80° NW. The footwall is a fine-grained black schist, and the hanging wall is diorite at the crosscut. A few feet to the southwest, both walls are diorite. From the crosscut, drifts run both ways to a total length of 300 ft. A shaft, 70 ft. deep, was full of water at the time of our visit. A 45-ft. raise from the drift to the surface could not be entered. The ore is said to assay $16 in gold, part of which is in the sulphides. A two-stamp mill with a 20-hp. gasoline engine, and circular concentrating-table, 10 ft. in diameter, was not in operation.

Otis Johnson, 241 Grant Street, Eureka, holds one claim adjoining the Salmon Summit. A 150-ft. drift tunnel exposes a one-foot quartz vein in diorite. It strikes east and west, and has a vertical dip. The white quartz pans free gold. No recent assays had been made at the time of our visit. About 1901, it is said that 10 to 12 tons of ore containing $100 per ton in gold were mined from this vein, and packed to the Gilta mill five miles north.

Salyer Consolidated Mines Company (Hammer, South Fork, see Swanson Mining Corporation also), some years ago, controlled 485 acres of patented land and 1350 acres of unpatented mining claims in Secs. 13, 14, 15, 22, 23, 24, 26, 27, 31, T. 6 N., R. 5 E., H. M., and Secs. 18, 19, T. 6 N., R. 6 E. The property is at the confluence of Trinity



(Photo by courtesy of Swanson Mining Corporation)

FIG. 14. Salyer Mine, Campbell Creek Siphon of 42- and 54-inch pipe.

River and its South Fork, just east of the Humboldt County line, and on the Redding-Eureka highway. It has been described under the earlier names in our Bulletin 85, and Reports of the State Mineralogist, references to which are given in the accompanying table of mines under the name of Swanson.

Terraces on which deposits of gravel remain are found at different altitudes from river-level to the top of the ridge, nearly 1500 ft. higher. The writer has noted nine such terraces at different altitudes. The gravel contains both gold and platinum in places, but of course the distribution is far from uniform. Most of the gold is very finely divided.

Salyer Consolidated Mines Company equipped the property for operation on a large scale as a hydraulic mine. C. M. Salyer of Salyer was president, W. D. McIntosh was secretary, and D. E. Carleton was general manager. An eight-mile ditch with a stated capacity of 80 cubic feet per second was built to Hennessy Creek. No water was available for this in the season 1930-1931. Water was taken from Campbell Creek in a ditch and two inverted siphons stated to have a capacity of 5000 miner's inches. Head available on the lower terraces at altitudes of 600 to 800 ft. above sea level was 200 to 350 ft.

During the season, 1930-1931, 300,000 cubic yards of gravel was mined from two pits, one on the Trinity River side of the ridge, the other on the South Fork side. Gold and platinum were recovered in sluices 5 ft. wide and 4 ft. deep with 12-inch wooden blocks for riffles. Sluices had lengths as follows: at the low pit on Trinity River side, 300 ft.; at a pit near the camp on Trinity River side, 1300-ft. altitude (not worked in season 1930-31), 1000 ft.; on the South Fork side, 550 ft. The company did some mining during several subsequent seasons; but for several years the property has been in the hands of Swanson Mining Corporation, which see. Additional equipment has been added by this corporation.

Sewell—see Gunther Group.

Shasta Hydraulic Gold Company, c/o Wm. D. McCantey, Room 2907, 120 Broadway, New York City, has acquired 1300 acres of the old Estabrook property near Trinity Center in Secs. 7, 8, 9, T. 36 N., R. 7 W. A lease on 300 acres of this is held by L. G. Crow, C. B. Demarest, and Fred Fulton of Trinity Center. They are working gulch gravels and small terraces of Sioux Creek by the hydraulic method. A ditch, 7½ miles long, with a capacity of 1600 miner's inches, takes water from North Fork of Swift Creek and Lick Creek. In April, 1939, about 1000 miner's inches were available with a head of 190 ft. A no. 2 giant with a 3-inch nozzle, and a no. 3 giant with a 4-inch nozzle were in use. During the season, 1938-1939, lessees expected to mine 100,000 cubic yards of gravel of an average depth of 15 ft. For the season, 1939-1940, they were planning to mine Hatchet Creek, the next creek to the north. H. H. Coffee, Trinity Center, is local agent for Shasta Hydraulic Gold Company.

Sheridan Mine in Sec. 19, T. 33 N., R. 10 W., two miles up Trinity River from Junction City, is said to be owned by Dr. T. C. Muegge, 450 Sutter Street, San Francisco, and J. J. Morgan, Junction City.

A patented tract of 104.25 acres of the same name, in the same section, is assessed to the estate of J. S. Sheridan, c/o Wm. J. Dryden, 760 Haight Street, Alameda.

During the season 1938-1939, gravel from a low terrace of Trinity River was being moved by a bulldozer to a stationary washing-plant. Overburden to a depth of 30 ft. was first removed by hydraulicking. A water-right calling for 3 cubic feet per second from a gulch just above the mine is held; and this amount was available for the season, 1937-1938. During the season, 1938-1939, only about one cubic foot per second flowed into two small reservoirs. Gravel mined by the bulldozer is dumped on an 18-inch belt conveyor, 70 ft. long between pulley-centers, which raises the gravel to a height of 24 ft. It is then washed in a trommel 48 inches in diameter by 16 ft. long. A scrubber-section, 7 ft. long, is not perforated. The balance is perforated with holes from 3 inches to 6 inches in diameter. Undersize drops to a sluice for recovery of gold. It is 18 inches wide and 200 ft. long. The first 30 ft. is equipped with heavy screen of ½-inch mesh. The upper end of this rests on the bottom of the sluice, then it is gradually raised on supports 18 inches apart until the lower end is 2 inches above the bottom. Vibration of the screen caused by the pounding of the small cobbles passing over it keeps the sand from packing; and practically all of the gold-recovery is made under the screen. The balance of the sluice is equipped with pole-riffles running lengthwise. The grade is 9 inches to 12 ft. At the time of our visit, about 75,000 cu. yd. of overburden and 500 cu. yd. of gravel had been mined. A 5-kw. electric generator is driven by a 12-inch Pelton wheel, and the trommel is driven by a 2-ft. Henry wheel similar to a Pelton.

Water is supplied through 800 ft. of 15-inch pipe and 300 ft. of 11-inch pipe. A no. 2 giant with a 3-inch nozzle and a no. 3 giant with a 4-inch nozzle are in use. Head is 300 ft. During the season, 1938-1939, water was sufficient for operating only 2 to 2½ hours out of 24 hours. Washing plant has a capacity of 100 cu. yd. (loose measure) per 8-hour shift.

Silver Grey includes two unpatented lode claims, Big Timber and Lucky Swede, held by George Greig, Ted Lindquist, and M. O. White of Junction City, and George Bergin, Weaverville. It is reached by 1¼ miles of trail from the road along Canyon Creek. The township in which it is located has not been subdivided into sections. The approximate location is Sec. 33, T. 35 N., R. 10 W., on the ridge between the lower main forks of the East Fork of Canyon Creek, at an altitude of 5000 ft. R. L. Carter of Weaverville is said to have produced $40,000 to $45,000 in gold, about 40 years ago.

A lower adit has been driven 78 ft. through a hornblende-biotite-diorite, then turned to drift for 32 ft. on a fracture marked by a gouge seam. Quartz lenses are found on this of a maximum width of two ft. plus a foot of mineralized diorite. Two samples quartered from grabs from the wheelbarrow taken while the drift was being driven were stated by White to have assayed $11 and $15 per ton in gold, with gold figured at $20.67 per ounce. An adit 54 ft. higher includes 30 ft. of drifting on a gouge seam, with some quartz in the diorite on both sides of the seam for a width of 4 ft. The strike varies from east and west to N. 50° E., and the dip is 70° south.

About 600 ft. to the north are the dumps of the old workings indicating that they had a possible length of some 2000 ft.; also depressions marking the places where old stopes have caved. Present owners have driven a crosscut adit in the diorite for 125 ft. to tap the vein found in the older workings at an altitude 40 ft. below where it was stoped. Some of the old workings were below this; but White thinks that the vein was not found in these. The production mentioned above is stated to have been from ore assaying $20 per ton. An arrastra was first used, then a Huntington mill driven by water-power.

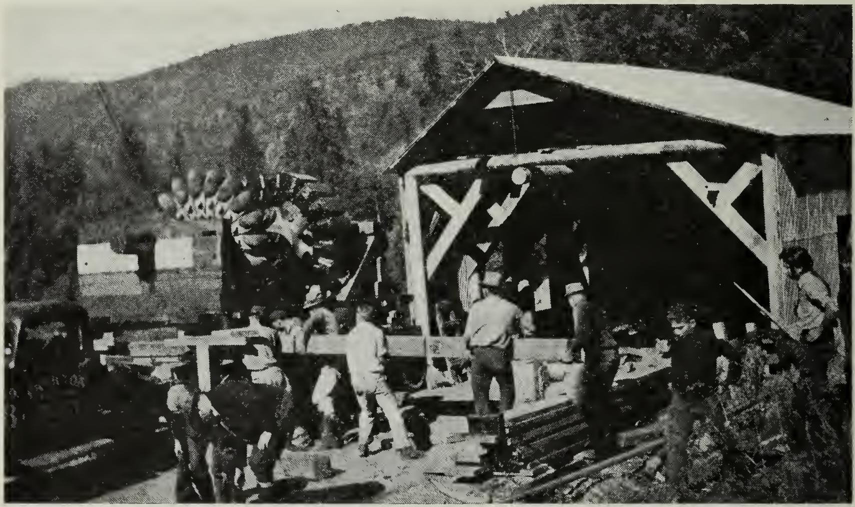
Starvation Mine includes three unpatented claims and a fraction, total 70 acres, in Sec. 11, T. 33 N., R. 8 W., held by F. L. Lewis of Lewiston, who made the discovery in 1932. Small fissure veins carry quartz and gold. Lewis works alone, and has driven two adit levels, 30 ft. apart in altitude. The lower adit comprises 200 ft. of drifting and crosscutting, the upper one 55 ft. of drifting. From the lower level, a stope 30 ft. in length has been driven. High-grade ore is found in the vein in average widths of 3 inches and 4 inches, with a maximum of 8 inches. Intrusions of both diorite porphry and granite porphyry form the walls of the vein, which is associated also with a peculiar breccia containing partly rounded fragments of Bragdon slate. Probably it is a fault breccia. The workings are in the oxidized zone; and the ore consists of quartz and oxides of iron carrying free gold. It is milled in a small stamp-mill on a nearby property.

Swanson Mining Corporation is now in control of the property formerly held by Salyer Consolidated Mines Company, which has already been described in this report. A. J. Swanson is president, C. A. Swanson is vice president, and J. B. Blair is secretary-treasurer, Salyer, Trinity County, California. It is a Delaware corporation with eastern offices in care of Rogerson, Clary, and Hewes, Jamestown, New York. Patented property is in Secs. 14, 15, 22, 23, 26, 27, T. 6 N., R. 5 E., H. M.

In order to provide a water-supply for the higher terraces, Swanson Mining Corporation has installed a hydro-electric plant of 2000-hp. rated capacity. Part of the water from Campbell Creek is used to generate power, and part is boosted by pumps to the mine. In 1939, connected load was 1200 hp. Starting at the diversion dam, the water system comprises 1065 ft. of flume, 6 ft. by 4 ft., a siphon of 500 ft. of 54-inch pipe and 300 ft. of 42-inch pipe, the latter being on a suspension bridge across Campbell Creek, then an open ditch, 7100 ft. in length. From this, 5400 ft. of 42-inch pipe runs to the power house, then 1125 ft. of 42-inch pipe and 350 ft. of 24-inch pipe, the latter being on a suspension bridge across South Fork of Trinity River, continues toward the mine. Following this are 3500 ft. of 30-inch pipe and 500 ft. of 26-inch pipe to no. 1 pump house, then 2400 ft. of 24-inch pipe to no. 2 pump house, then 400 ft. of 24-inch pipe, and 300 ft. of 18-inch pipe to the mine. In the pit, 15-inch pipe is used. The first pump has a 20-inch suction line, and a 16-inch discharge line, and is driven by a 600-hp. motor. The head at the power house is 600 ft., and the first pump is placed at such an altitude on the side of the canyon that a 60-ft. pressure is maintained on the suction side. This pump boosts the water to the second pump, which is

200 ft. higher. The second pump has a 14-inch suction and a 12-inch discharge. It is driven by a 600-hp. motor. Both pumps are single-stage centrifugals. Head maintained in the pit is about 180 ft. Pressure on the discharge side of no. 2 pump is 125 to 135 lb. per square inch. The 2000-hp. alternating current generator is driven by a Pelton wheel. Water right on Campbell Creek calls for 40 cubic feet per second.

The working-pit, excavated mostly during the season, 1938-1939, was roughly 500 ft. long by 300 ft. wide by an average of 50 ft. deep at the time of our visit. The face was 110 ft. high, and was made up largely of sand and clay, said to contain enough gold to pay for handling it. Beneath this was 30 ft. of gravel carrying gold in flat flakes as large as one-eighth of an inch along the edges, also fine gold. Some grains of the size of grains of wheat are recovered. Bedrock consists of alterating bands of slate and schist with steep dips. Bands are each a few feet in width. Two hydraulic giants with 4-inch or 5-inch, sometimes 6-inch, nozzles were in use. Experiments were being made in blasting down the bank in advance of hydraulicking.



(Photo by courtesy of Swanson Mining Corporation)

FIG. 15. Swanson Mining Corporation, Pelton wheel and armature of generator.

Recovery of gold and platinum is made in a sluice, 360 ft. long, with a grade of three-quarters of an inch to the foot. It is 43 inches wide and 36 inches deep. Riffles are of 45-lb. steel rails set ball down or flat side up, and with this flat side sloping one-half inch to the width of the rail in the opposite direction to the slope of the sluice. Spaces are 1½ inches. At the end of the sluice is a grizzley in two sections, 4 ft. and 12 ft. long respectively, made of rails with the ball up, and the flat side cut off. Between these two sections is a section of grizzley made of manganese steel bars, one inch wide on the top and one-half inch wide on the bottom, and six inches deep. Sizes of less than one-half inch pass through the grizzley to undercurrents, which are similar to the tables on a dredge. They are fed by a sluice, in the bottom of which is a screen of steel plate punched with 5/16-inch holes. It is 60 ft. long, 2 ft. wide, and slopes one inch to one foot. Eleven tables, each 4 ft. by 20 ft. are equipped with steel-shod Hungarian riffles. They slope 1½ inches to 1 foot. Quicksilver is used in the first two feet.

Tables are arranged so that any one of them can be cleaned up while the others are in service. The concentrate flows in a V-trough to a small pump, which raises it to a trommel, 4 ft. by 2 ft., with a 7-mesh screen. Oversize is discarded. Undersize drops to a hopper, from which it is fed to a two-cell Pan American jig, with cells 12 inches square. Concentrate from the jigs is treated in 300-lb. batches in an amalgamation barrel, 18 inches by 24 inches. Each batch from the barrel is discharged to a metal sluice containing a trap in which are jets of water to keep the sand from packing. About five pounds are saved here from the 300-lb. batch, in which are the amalgam and the platinum-group metals. Rejects still contain some gold coated

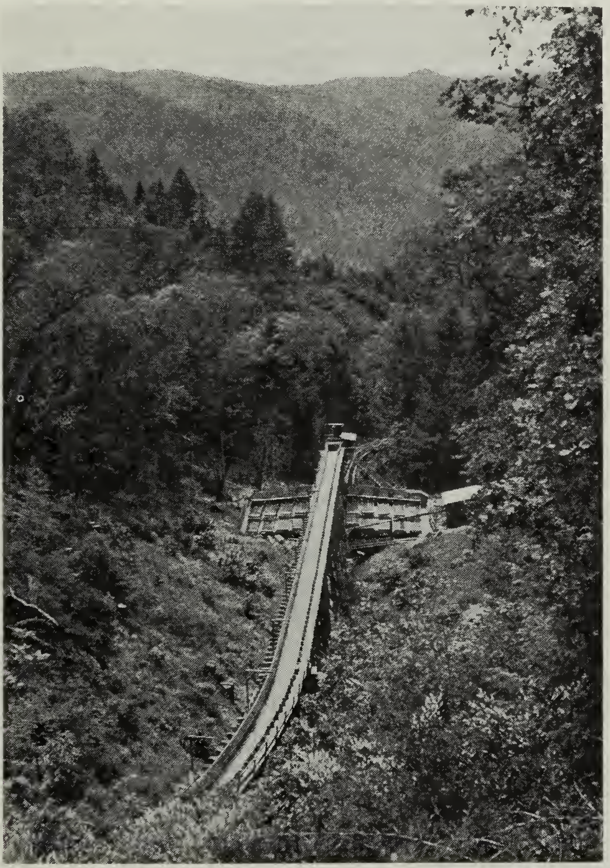


FIG. 16. Swanson Mining Corporation, sluice and undercurrents.

with secondary pyrite, and these are ground from time to time for additional recovery by placing rods in the amalgamation barrel.

Below the grizzley in the main sluice is an 800-ft. tailing sluice discharging to Trinity River. It is equipped for its entire length with riffles of 35-lb. and 45-lb. steel rails. A tract of mineable gravel of 25 acres has recently been developed by the drilling of 18 holes to average depth of 80 ft. to 90 ft. Maximum depth was 122 ft. A total crew of 25 men work on three shifts. Water is usually available for the full seven-month mining season. In 1938-1939, thirty percent of the season was lost on account of shortage of water.

One ounce of platinum-group metals is recovered to each 20 ounces of gold. An analysis of a shipment follows:

Platinum	28.0%	Iridium	30.8%
Ruthenium	10.0%	Osmium	25.0%
		Waste	6.2%

Tri-M, a partnership of F. L. Morrison, W. L. Merrill, Douglas City, and Wm. Maakestad, Sacramento, built a small cyanide plant on the *Oriole* property of Maurice Collins, Douglas City, in 1937. The location is in Sec. 25, T. 32 N., R. 9 W. At the time of our visit, the treatment of 210 tons of tailing from the Oriole had been completed. It was agitated in two Devereaux agitators, 9 ft. by 9 ft. Solution was decanted to a settling-tank; and precipitation was accomplished in zinc-boxes. One box filled with excelsior was used to clarify the solution. Power was furnished by an automobile engine. Operators stated that they would add a crusher, 4 ft. by 5 ft. Marcy mill, and rake-classifier, to give the plant a capacity of 10 tons of quartz ore per 24 hours. They planned to haul ore from the Phillips Group, Dixie Queen, Bully Choop, and other properties. A new road, three miles long, had just been completed to the Phillips Group, and the road to the Bully Choop was being repaired.

Trinity Dredging Company, Miss Mary Smith, president, Lewiston, operated a dredge for many years in Secs. 4, 5, 6, 7, 8, T. 33 N., R. 8 W., four miles north of Lewiston. C. R. Harris was dredge master. In 1939, the dredge was leased by C. R. Harris and T. D. Harris; and the work was extended to the north near the line between Sec. 4, T. 33 N., R. 8 W., and Sec. 33, T. 34 N., R. 8 W., on land owned by Joe W. Martin.

The bucket-line of the dredge carries 42 buckets of 11-cu. ft. capacity and 42 links of the same length as a bucket. When the bucket-line is heavily loaded, these links carry about 2 cu. ft. each. Nine buckets are dumped per minute. Gravel is washed in a trommel with 6-inch and 8-inch holes. Oversize, up to 4 ft. in diameter, is dumped over the side through chutes. Undersize goes through the holes in the trommel to a sluice 125 ft. long, 4 ft. wide, and 2 ft. deep. The lower part of the sluice, 110 ft. long, is carried on a scow behind the dredge. Separate drums are provided on the winch to swing the sluice for proper distribution of tailing, which is deposited so that the surface is left nearly level. Riffles are made of 2-inch by 3-inch steel angles with 2-inch face up and 3-inch face vertical. Spacing between angles is 2 inches. The tops are protected with manganese-steel castings, one inch thick, made with bars two inches wide alternating with 2-inch openings. The castings are in sections 4 ft. square. Some of these assembled riffle sections, 4 ft. square, are placed with bars lengthwise of the sluice, but most of them are placed crosswise. The hull of the dredge is 110 ft. long, 50 ft. wide, and 7 ft. deep, and draws about 5½ ft. of water. It is provided with two steel spuds of 25 tons each.

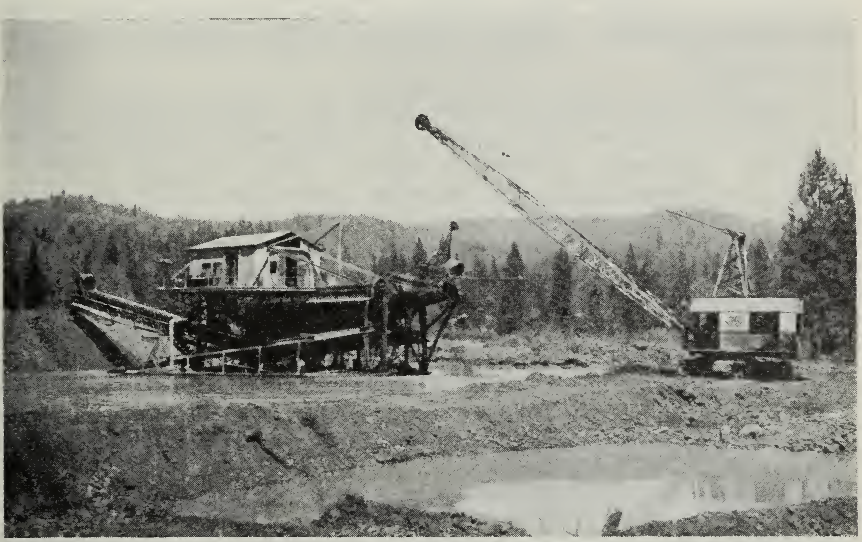


FIG. 17. Trinity Dredging Company.

List of motors, all taking power from lines of the Pacific Gas and Electric Co. at 2200 volts, follows: 150-hp. digging motor geared to bucket-line with herringbone gears, no belt; 52-hp. winch motor driving 10-drum winch; 100-hp. on 16-inch certifugal pump; 35 hp. on 6-inch centrifugal pump; 25-hp. on trommel; 25-hp. on compressor and other shop tools; 50-hp. on shore pump needed at times to keep the pond full of water. References to older reports on this dredge are contained in the accompanying table of mines.

United Trinity Mines (Trinity Bononza King), a corporation in bankruptcy, John R. Ives, trustee, 805 Mills Building, San Francisco, posted an 'Intention to Hold' the following in 1937: Gold King Quartz Mine, Bonanza King Quartz Mine, Bonanza King Quartz Mine No. 2, Bonanza Queen Quartz Mine, Bononza Queen No. 5 Quartz Mine, Sunset Quartz Mine, Sunset No. 2 Quartz Mine, Sunset No. 3 Quartz Mine, Young America Quartz Mine, Valley View Quartz Mine, Copper Mountain Quartz Mine, and Bugle Hill Placer No. 1 of not more than 240 acres. From Sec. 30, T. 37 N., R. 6 W., these claims extend in a northwesterly direction for 4½ miles. In 1937, the buildings at the mine, the portal of the lower tunnel, and part of the road were in a wrecked condition. The power house on East Fork of Trinity River was not visited. The 1939 address from the office of the county assessor is c/o A. B. Kreft, Attorney, 805 Mills Building, San Francisco. References to earlier reports on the extensive operations at this property are contained in the accompanying table of mines.

Up Grade Placer Mine of 110 acres in Sec. 7, T. 6 N., R. 7 E., H. M. is held by Louis A. Maire of Denny. It is three miles by road southwest of Quinby (Denny P. O.) at the confluence of New River and Panther Creek. Sampling by the owner, consisting of groundsluicing, open cuts, tunnels, and shafts, is stated to have demonstrated that 2,000,000 cubic yards of gravel of an excellent grade for hydraulic mining are available. He proposes to work the deposit with water from Panther Creek. In 1939, equipment for this purpose had not yet been installed.

Upham Hydraulic Mine (Pine Tree) has been described in State Mineralogist's Report XXIX, p. 72. It includes 80 acres of patented land and additional unpatented mining claims held by Frank L. Upham and Sarah E. Upham, Douglas City, in Sec. 29, 30, T. 32 N., R. 8 W. Since that report was written, the mine has been equipped with a new water-supply from Indian Creek. Equipment includes a new flume, 3380 ft. long, 4 ft. by 3 ft. in section, on a grade of one-quarter of an inch to 12 ft. Its capacity is about 2000 miner's inches of water. No reservoir was provided, and this amount of water was not available during the season, 1938-1939. Pipe includes 80 ft. of 30-inch, 1800 ft. of 24-inch; 200 ft. of 18-inch, 200 ft. of 15-inch, and 320 ft. of 11-inch. Two giants are used, a No. 3 with 4-inch or 5-inch nozzle, and a No. 4 with a 4-inch, a 5-inch, or a 6-inch nozzle. Head varies from 150 ft. to a maximum of 230 ft. available at the lower part of the property.

The mine is leased to D. M. Anderson, 641 O'Farrell Street, San Francisco, who had two men working in 1939. Not much mining had been done during the season because of water-shortage.

Venecia Mine includes one patented claim and additional unpatented claims in Sec. 3, T. 33 N., R. 8 W., held by Paulsen Bros., Lewiston. The distance from Redding is 34 miles, half highway and half mountain road crossing a 4000-ft. summit. Quartz veins varying in width from a few inches to 5 ft. occur on the property. Country rock is Copley meta-andesite, granite porphyry, and a little Bragdon slate. In 1939, three leases were in operation, one held by R. S. Moore and E. O. Moore of Lewiston, one by Harvey Clayton of Lewiston, and one by Charles Chisman and W. F. Grubb of Lewiston.

The Moore and Moore lease extends from the old no. 5 Venecia level upward to the surface. They have driven a new adit level at the same altitude as that of the old level. It consists of 90 ft. of crosscutting to a small vein and 115 ft. of drifting on the vein, which strikes N. 30° E. and has a steep dip to the northwest. It averages 3 inches to 4 inches in width. A number of shipments of $400-gold ore, averaging two tons to three tons each, have been made to smelters during the past few years. The ore is largely oxidized, and much of the gold is free; but considerable amounts of galena, pyrite, and arsenopyrite are contained also. Some of the ore is rich enough so that extraction of the gold by grinding in a hand-mortar is feasible. A stope about 10 ft. long has been started above the adit-level. This level is entirely in granite porphyry, but a contact of this formation with Copley meta-andesite has been exposed in some of the old Venecia workings to the north.

Clayton's lease extends from the Venecia no. 5 level downward. At the time of our visit, he was driving a new adit level to reach the same vein that is exposed in the Moore and Moore workings. Clayton's adit is 60 ft. lower in altitude. At the 140-ft. point, it was being turned from an easterly trend to N. 30° E. to follow a small vein that may be the same as the one exposed by Moore and Moore. At this level, the ore is not oxidized, and consists of one inch to four inches of quartz carrying galena, pyrite, arsenopyrite and free gold. The dip is 72° east; and both walls are granite porphyry.

The third lease, held by Grubb and Chisman, is several hundred feet higher in altitude than the other two. The main road to this property and to the Paymaster mine crosses the outcrop of the Venecia vein near the point where the original discovery was made. The lease extends upward from an altitude 50 ft. below the road. A new level has been driven on a fracture in Copley meta-andesite. The strike is N. 30° E., and the dip is 58° SE. At the time of our visit, the length of the level was 150 ft.; and a raise 60 ft. high on the dip of the fracture had connected with a 50-ft. adit above, which was driven by former lessees. A few tons of high-grade ore were produced from this upper level, where the hanging wall is slate; and a little good ore has been taken from bunches, an inch or a few inches wide, by present lessees. At a distance of 50 ft. to the east of these workings, is a 50-ft. dike of granite porphyry in contact with Bragdon slate. Plans called for driving the adit ahead to explore the contact.

Vermont Mine (Willey) comprises the Vermont, West Point, Vermont No. 2, and Vermont Extension, in Sec. 13, T. 33 N., R. 8 W., held by J. H. Blagrave and Gertrude Blagrave of French Gulch, and B. A. Graham and Mattie Graham of Ydalpom. The mine is a mile south of the old Tom Green road, at an altitude of 3500 to 4000 ft., and is reached from Redding by 30 miles of road, half highway and half mountain road. In 1939, it was leased to E. L. Vinal of Redding; and under this lease Richard S. Eskridge, mining engineer, 700 Insurance Building, Seattle, Washington, was working. The patented Montezuma claim of Niagara Summit Mining Company adjoins.

Quartz veins are associated with dikes of diorite porphyry intruded into Bragdon slate. An adit level, roughly 300 ft. in length, said to have been driven in 1883, has been cleaned out. It starts in an easterly direction, but branches in various directions to follow contacts of diorite porphyry and slate. Quartz stringers in the slate near these contacts are considerably crushed and broken. The mixture of quartz and slate is said to give good assays in gold. Numerous other old adits have been driven to develop similar contacts, but they have caved. Dumps are composed of a mixture of quartz, slate, and diorite porphyry. Plans called for the treatment of this dump-material in a mill comprising a crusher, 5-ft. Huntington mill, plate for amalgamation, and Wilfley table. Installation of the Wilfley table was being made at the time of our visit. A Buick gasoline engine furnished the power. Free gold is said to amount to 25% of the total gold in the ore; the balance is in the sulphides, largely pyrite. Three men were working.

Viking Dredging Company is under the same management as Interstate Mines, Inc., Box 498, Chico. E. B. Noble is president and J. C. Hamilton is secretary-manager. A. B. Ogilvie, Weaverville, is in charge of operations. The company operates a dragline dedge in Sec. 12, T. 32 N., R. 10 W., at the confluence of Redding Creek and Trinity River, near Douglas City. Terraces of both Redding Creek and the river are worked. Washing-plant was manufactured by Judson-Pacific Company, 609 Mission Street, San Francisco. Details of this method of dredging are contained in our California Journal of Mines and Geology, issue of April, 1938.

Weaver Dredging Company controlled by R. C. Dempster and Oscar R. Batham, Weaverville, operated two dragline dredges in 1939. Terraces of both Weaver Creek and Trinity River were worked in Sec. 1, T. 32 N., R. 10 W., and Sec. 6, T. 32 N., R. 9 W. The East Fork of Weaver Creek was worked near Weaverville, Sec. 7, T. 33 N., R. 9 W. Available ground in these locations appeared to be about worked out late in 1939. Details of this method of dredging are contained in our California Journal of Mines and Geology, issue of April, 1938. For handling large boulders, some of the later plants are equipped with a grizzley over the hopper. This grizzley has a flat slope downward toward the dragline-shovel. Large boulders lie on it until dragged off into the pond by means of the bucket. If the pond is shallow, the boulders must then be picked up again to get them out of the way of the barge. This sometimes results in loss of considerable time, so an effort is made to lay large boulders aside with the dragline rather than to place them on the grizzley.

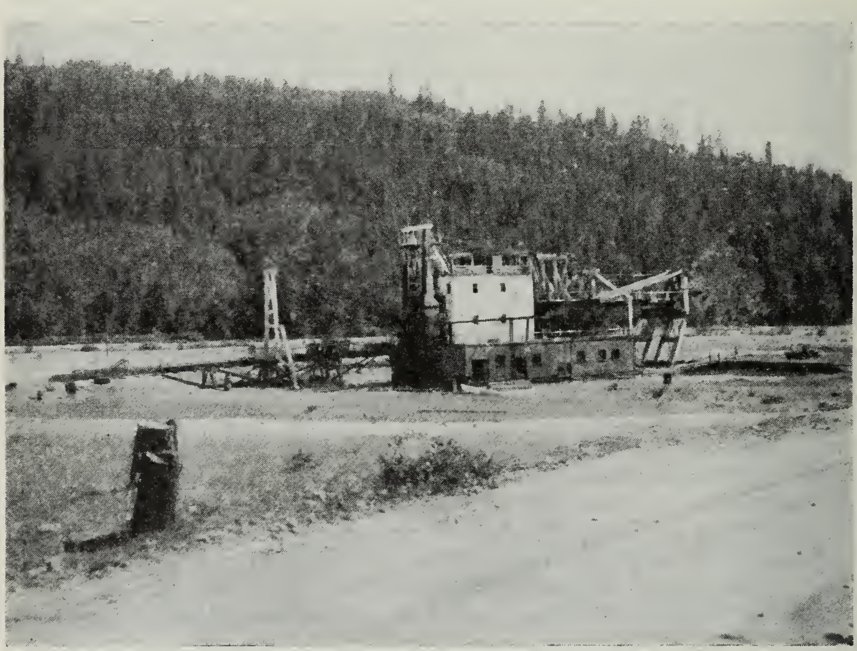


FIG. 18. Weaver Dredging Company.

Woodbury Mine is a small hydraulic mine on a high terrace of the East Fork of Weaver Creek, near Weaverville, in Sec. 7, T. 33 N., R. 9 W., operated by Willis Woodbury of Weaverville. Terrace gravels are worked for an average depth of 10 ft., down to a bedrock of the Weaverville (Tertiary) sediments.

Yellow Surprise is a lode claim in Sec. 10 (?), T. 33 N., R. 11 W., held by Clarence Kunkler and Jack Smith of Junction City. It is on a ridge west of Spruce Gulch and Conner Creek, at an elevation of about 3500 ft., just across Trinity River from Junction City, from which it is reached by two miles of road, then a mile of trail up the ridge. A lense of quartz with a maximum width of 3 ft. is exposed in a 25-ft. adit. A picked sample of this is said to have assayed $29.70 per ton, of which $1.50 was silver, the balance gold. Gold was figured at $20.67 per ounce.

GRANITE.

A little granodiorite has been quarried on Rush Creek, six miles east of Weaverville, for local use for monuments and buildings.

LIMESTONE AND MARBLE.

Limestone and marble are common in the county, but have been developed very little on account of distance from markets. Local use has been made in Weaverville of limestone quarried on Brown's Mountain in Sec. 21, T. 33 N., R. 9 W., and in Sec. 3, T. 33 N., R. 10 W. This was burned in small kilns, but there has been no recent production. The remoteness of the county, and small local population are unfavorable to the development of deposits.

Bibl: Calif. State Division of Mines Bull. 38, p. 94; State Mineralogist's Report XIV, p. 920. Diller, J. S., Amer. Journal of Science, 4th Series, vol. 15, p. 342.

MANGANESE.

Goat Camp Group of two unpatented claims in Sec. 35, 36, T. 29 N., R. 11 W., M. D. M. is held by George Biewert and W. O. Friend, Hayfork. These claims are on the divide that forms the boundary-line between Trinity and Shasta counties at an altitude of 5000 ft. The distance from Redding by county road and steep forest road is 60 miles by way of Igo, Platina, and Harrison Gulch CCC Camp. At a point 200 yards from a forest road is an outcrop of hard black oxides of manganese, 5 ft. by 10 ft. At a distance of 25 ft. in the direction S. 35° E. is an old open cut, 5 ft. deep, with similar manganese ore on the dump. Sloughing of the sides has resulted in the filling of the lower part of the cut with soil. When some of the black chunks are broken, pink rhodonite and white quartz are found in the center. Country rock is chert, but the deposit is very close to a serpentine contact striking southeast. The chert is colored green, probably due to some absorption and recrystallization during the intrusion of the serpentine.

McKnight Group held by J. M. McKnight, Box 621, Scotia, is in the Hayden Roughs at the head of Mad River, Sec. 16, 17, T. 26 N., R.

12 W., M. D. M. The owner states that he has developed 800 tons of ore high in manganese and low in silica by stripping an outcrop 6 ft. to 10 ft. wide and 150 ft. long. The following is involved in order to ship this ore by water from Eureka: construction of five miles of new road through very rough country; about 17 miles of road designated by the U. S. Forest Service as 'poor motor road (under 15 miles per hour)' to reach Ruth; 40 miles of dirt road, Ruth to Bridgeville, some steep grades; 46 miles oiled and paved road, Bridgeville to Eureka. The railroad at Carlotta is 27 miles closer; but all-rail freight rates to points of consumption in the eastern part of the United States are about equal to eastern quotations for manganese ore during the early part of 1940.

Old Bill in Sec. 9, T. 28 N., R. 11 W., M. D. M., is a relocation of the Johnson property described in our Bulletin 76, p. 90. It is held by T. E. Reynolds, City Clerk-Attorney, Davis, California. During the war of 1914-1918, this property was at a distance of 14 miles from the nearest road, and Noble Electric Steel Company transported some of the ore for that distance by pack-train. The claim is a mile or more south of Pine Root Spring near the head of Prospect Creek.

Hard, black oxides of manganese outcrop and are exposed by shallow cuts in eight places in a total distance of 600 ft. Width is about 6 ft., and the longest exposure in one place is 30 ft. Strike at the upper exposures is N. 52° W. and dip is 51° SW. The hillside slopes in the same direction as the dip at a flatter angle with the horizontal. Some depth could be gained by stripping off the hanging wall from the surface. Country rock is a sedimentary series, chert and greenish slate, probably chloritic. Possibly some volcanic material is interbedded.

A new forest-road reaches Pine Root Spring. From this point, which is at an altitude of 4600 ft., a mile or a little more of new road is needed to reach the claim at an altitude of 4000 ft. The distance from Redding by way of Igo, Platina, Harrison Gulch CCC Camp, and Red Mountain Road to Pine Root Spring is 65 miles. Parts of the road are narrow, steep, and winding. A road from Wildwood also connects with the Red Mountain road.

Skaggs and Foss Group of two claims in Sec. 15, 22, T. 29 N., R. 11 W., M. D. M., are held by C. Skaggs and Fred Foss, Cottonwood. Skaggs states that manganese ore has been exposed in four or five places by cuts, 6 ft. in depth, in a length of 300 ft. and width of 20 ft. He furnishes the following analysis of a picked sample: Mn, 50.30%; SiO_2, 11.65%; Al_2O_3, 0.75%; Fe, 0.94%; P, 0.04%; Zn, none. The claims are half a mile south of the mouth of Dubakella Creek and half a mile from a U. S. Forest Service road. The altitude is 4000 ft. and the distance from Redding is about 65 miles.

Spider Group of three claims, in Sec. 17, T. 28 N., R. 11 W., M. D. M., was located April 27, 1940, by Wm. Friend of Hayfork, and H. L. Fox of Weaverville. The group is optioned to John D. Rourke, Weaverville. The distance from Redding to the present end of the road is 66 miles. All of this is county and forest road, and the last 20 miles is through rather steep mountains. An additional four miles must be built to reach the deposit. A spring of water is found on the claims, and the region is well timbered.

Hard black manganese oxide, probably largely psilomelane, outcrops for a width of nearly 100 ft. and a length of 600 ft. The width given is near the center; it appears to decrease near the ends. These dimensions give only a very rough idea of the deposit, because more than half of the area indicated is covered by overburden. Trenching is needed to show whether the deposit is continuous or not between outcrops. Quartz veinlets, varying from an inch to several inches in width, run across the deposit every few feet. The outcrops are along a small ridge running in a nearly north and south direction.

Both walls of the deposit are of chert, but float to the east indicates that a diorite or gabbro intrusion is nearby. Some of the chert along the walls of the manganese deposit appears to have been injected to a small extent by this igneous material. Altitude at the deposit is 4500 ft.

MINERAL PAINT.

Red Ocher has been reported to occur in Sec. 15, T. 35 N., R. 8 W., on the east side of the East Fork of Stuarts Fork; and in Sec. 9, T. 35 N., R. 8 W., according to Bulletin 38 of this division, p. 342. Low prices for this mineral and distance from a railroad handicap utilization.

MINERAL WATER.

Deer Lick Springs in Sec. 6, 7, T. 30 N., R. 9 W., is owned by California Medicinal Springs Company, 22 Cliff Street, New York City. The water is used for bathing and drinking by sick persons, who camp in the vicinity. The United States Forest Service has recently completed a road connecting Harrison Gulch in Shasta County with the state highway running from Weaverville to Hayfork; and this road makes the springs readily accessible. One of the regular forest camp sites with benches, tables, and stoves has been provided. No other accommodations are available.

A flow of about eight gallons per minute of cold water issues from a group of five springs. The water is highly sulphuretted and contains quite a large amount of calcium, sodium, and combined chlorine. The springs are described in detail, with analyses, in U. S. Geological Water Supply Paper 338, pp. 261-263.

Other sulphur springs have been noted along Browns Creek, one mile and more downstream from Deer Lick Springs, but they have not been improved. Other undeveloped mineral springs have been noted high in the mountains of the northeastern part of Trinity County, near the Altoona quicksilver mine.

PLATINUM.

Platinum-group metals have been produced recently by Hayfork Gold Dredging Company from the Hay Fork of Trinity River near Hayfork, by Junction City Mining Company dredging in Trinity River near Junction City, and by Swanson Mining Corporation hydraulicking high terraces of Trinity River near Salyer. The platinum is produced as a byproduct of gold-mining in each case; and operations are described under the heading of gold in this report. Further details on the platinum, with analyses of the metal, are contained herein under the respective headings mentioned.

QUICKSILVER.

Quicksilver was produced in the Altoona district before 1875, by washing gravel containing cinnabar that had been eroded from the veins. The Altoona mine is estimated to have produced 1000 flasks before 1875. Bradley[1] estimated that Trinity County had produced 31,166 flasks to the end of 1917, of which the Altoona mine had produced approximately 29,000 flasks; although he found published records on this somewhat contradictory. During recent years, several hundred additional flasks have been produced, perhaps 1000. Figures have been concealed in the 'unapportioned' item in recent reports. A small production has been made recently from the New River district, as noted below under that heading. Activity in quicksilver mining was at its height in Trinity County from 1875 to 1879, and from 1895 to 1901.

Altoona Quicksilver Mining Company, J. Frowenfeld, president, owns property in Sec. 22, 26, 28, T. 38 N., R. 6 W., 24 miles by road west of Castella. The steep road crosses the ridge at an elevation of nearly 6000 ft.; and the property is at an elevation of 4500 ft. Production of this old mine has been noted above. It was worked by a shaft and winze to a depth of 600 ft. below the surface, with levels about 100 ft. apart. A heavy flow of water was encountered on the lower levels; and pumping was expensive. In the years around 1930, G. A. Larsen of Castella held a lease on the mine, and made a production of 100 to 200 flasks per year from veins 18 inches to 2 ft. in width above water-level, which was about 145 ft. below the surface. Country rock is a complex of gabbro and serpentine intruded by dikes. The whole is so much altered near the veins that a large amount of work is required to distinguish one rock from another.

In 1937, C. W. Erickson of Castella equipped the property with a new rotary furnace. It is a steel tube 42 ft. long with a diameter of 18 inches inside lining, set on a slope of seven-eighths of an inch to a foot. Lining is 6 inches thick, and consists of fire-brick, asbestos, and other insulation. Ore is fed to the tube by a belt feeder. A 13-inch suction fan, driven by a 3-hp. electric motor at 1100 rpm., maintains a slight draft into the furnace at this point. It also removes the fumes from the furnace and delivers them to a cyclone for dust-removal, then to a condenser consisting of 10 tubes made of a chromium-iron alloy, each 18 ft. long by 13 inches in diameter, of 18-gage metal. A water-spray is introduced into the first tube, and running water is passed over the outside of all tubes. Erickson planned to substitute a condenser of stainless steel immersed in a tank of water at a later date. Other equipment includes a 12 by 14-inch Blake crusher and a 120-ton fine-ore bin. An oil-burner is used in the furnace, and a small compressor furnishes air to atomize the oil. Some of the first material fed to the furnace included bricks from the old

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[1] Bradley, W. W., Quicksilver resources of California: Calif. State Div. Mines Bull. 78, p. 200, 1918.

Knox and Osborne furnace, which was wrecked, together with dump-ore.

In the summer of 1940, Erickson had a crew of 12 men at work. The rotary furnace was operated 24 hours per day with a capacity of about 30 tons. The feed consisted of sorted ore from the dumps and concentrate from a special type of concentrator that Erickson has developed.

Dump-ore is pushed toward the concentrator with a tractor and bulldozer and is fed to a hopper. A bucket-elevator feeds it to a trommel, to which water is fed also. Oversize goes to a belt-stacker, and lumps of ore showing cinnabar are sorted from this by hand. Undersize goes to a wide trough beneath the trommel, then through launders to revolving discs set in two inclined planes on either side of the trommel. The inclination can be varied. The machine is equipped with a total of four of these discs, each about 30 inches in diameter. The discs have spiral grooves in the faces, and the rotary motion causes the concentrate to travel along the spiral, up the incline, to a hole in the center of the disc, beneath which is a bucket to collect the concentrate. Tailing overflows at the edge of the disc to a device similar to a Dorr classifier. The sand-tailing is discharged by the rake in the classifier to the same belt that carries the oversize away from the trommel. Thus only the finest sediment must be carried away by the stream of water. About 150 tons of ore from the dump are treated daily in this way. The outfit has the appearance of a small 'dry-land dredge' and is mounted on skids for portability. Power for the furnace and concentrator is furnished by a Yellow-Knight engine burning stove oil, connected to a 35-kw. alternating current generator, and by a 30-hp. hydro-electric plant.

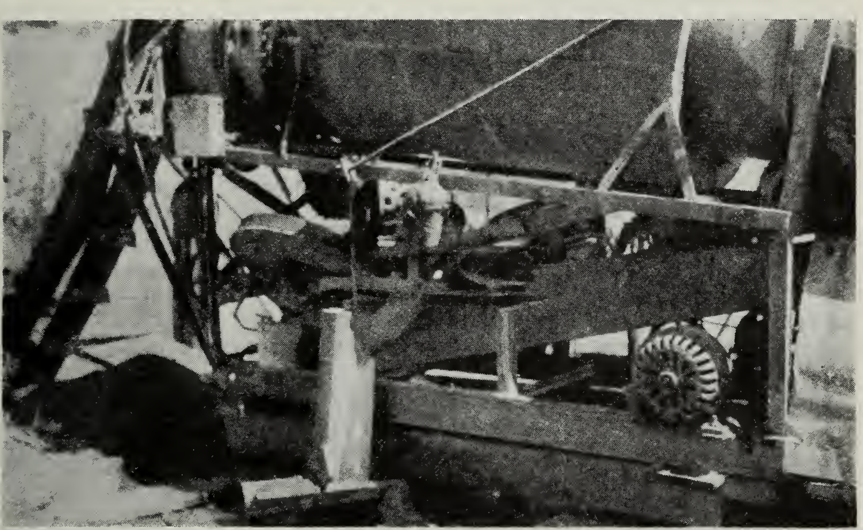

FIG. 19. Details of concentrator, Altoona Mine.

The old shaft is equipped with a hoist and a new steam boiler. A new vein similar to the one that Larsen mined has been discovered above water level, and production from it was expected to start shortly. Other plans call for unwatering the shaft to the lowest level, and possibly the driving of a long drain-tunnel at an altitude considerably below the lowest part of the old mine. References to earlier reports on this mine are contained in the accompanying table of mines.

Integral Quicksilver Mine in Sec. 15, 22, 23, T. 38 N., R. 6 W., near the Altoona mine, is assessed to Zack Anderson, Box 162, Middletown, Lake County, who is said to own also the Taggart quicksilver mine of 22 acres patented and the Trinity quicksilver mine of 54 acres patented, adjoining the Altoona.

In 1903, the mine had been opened by a shaft 180 ft. deep, with five levels, several hundred feet of drifts and crosscuts, and a winze 130 ft. deep below the 180-ft. level. The bottom of the winze connected with a 2760-ft. adit level. Some production was made with a 24-ton Knox and Osborne furnace.

Equipment and buildings are in a wrecked condition at this time (1939). A little development work has been done by Geo. R. Anderson, Box 16, Castella, and one or two other men.

New River District contains several quicksilver prospects, and seven or eight flasks of quicksilver have been produced in recent years by Charles Hahn, who used a retort. The ore came from surface cuts in Sec. 17(?), T. 37 N., R. 12 W., three-quarters of a mile northeast of the Boomer mine. The claims were relocated in 1939 by A. Z. Allen of Denny.

According to F. C. Meckel of Junction City, half a dozen outcrops of cinnabar in serpentine have been found four or five miles from the Allen claims on the East Fork of New River, and others on Milk Creek.

Shasta Lily is a single unpatented claim in Sec. 14, T. 38 N., R. 6 W., M. D. M., held by George L. Costa, Box 16, Castella. It is 20 miles by steep mountain road west of Castella, of which the last half-mile at the mine is not in good condition. Altitude is 4000 ft.

A stringer-zone in serpentine, carrying cinnabar, strikes N. 43° W., and has a vertical dip. Ore has been mined from a 20-ft. shaft and an open cut adjoining the shaft. In the summer of 1940, Costa was finishing a 75-ft. adit level, 30 ft. lower in altitude than the collar of the shaft. He expected to connect with the shaft with a few feet more of driving. Recent production, made a year or two earlier, amounted to two flasks of quicksilver. A concentrate is made by sluicing the ore, and the concentrate is treated in a D-retort of one-half ton capacity on the claim. The owner works alone.

TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Ackerman	P	19, 30	35 N.	10 W.	Canyon Placers, Inc.,[5] Dedrick	See Canyon Placers, Inc.
Alaska	Q	15	35 N.	11 W.	R. H. Junkans and F. Shaw, Weaverville	XI, p. 482; XIII, p. 437; XIV, p. 884
Alder Gulch	P	15, 22	33 N.	10 W.	John P. Booth,[5] c/o K. Booth, 140 N. 18th St., San Jose	No published reports
Alta Bert	P	4, 8, 9, etc.	36 N.	7 W.	Shasta Hydraulic Gold Co.,[5] c/o William D. McCantey, Room 2907, 120 Broadway, New York, N. Y.	See Shasta Hydraulic Gold Co. XIV, pp. 918-19; Bull. 36, p. 104; U. S. G. S. Bull. 540, p. 19
Altoona	Hg	22, 26	38 N.	6 W.	Altoona Quicksilver Mining Co., J. Frowenfeld, Pres., 2446 Washington St., San Francisco	IV, p. 336; VIII, p. 643; X, p. 716; XI, pp. 481, 482; XII, p. 371; XIII, pp. 603-04; XIV, p. 923; Bull. 27, pp. 192, 219; Bull. 78, pp. 200-201; XXII, pp. 65-66; XXVII, pp. 63-64. See text this report
Amy Balch	Q	13	33 N.	8 W.	M. G. Carter, Redding	XIII, p. 437; XIV, p. 884; XXIX, pp. 6-7. See text this report
Andy	P	3, 9, 10	34 N.	11 W.	Bert Higgins, Helena	No published reports
Annie McGrew						See Star of the East
Armstrong	Q	6	37 N.	12 W.	J. E. Miller	XIII, p. 437; XIV, p. 884
Arrow Point	Cr	24	28 N.	11 W.	Floyd Sublett, Redding	See text this report
Auto	P	13	1 S.	7 E.	A. H. Jens, Ruth	No published report
Bailey	Q	21 (?)	35 N.	10 W.	E. V. Reynolds, Dedrick	See text this report
Bald Point	P	33	33 N.	9 W.	Verne E. Bonneau,[5] c/o F. T. Van Atta, Mill Valley	XII, p. 313; XIII, p. 459; XIV, p. 901
Barthol Jacobs						See Goldfield Consolidated
Bateman & Mauldin	Q	14, 15	33 N.	8 W.		XXIX, p. 9
Bates & Van Matre	P	33	34 N.	8 W.	J. W. Martin, Lewiston[5]	XIII, p. 438; XIV, p. 901
Battle Peak	P				N. L. Hildrick, Copper	XVII, p. 543
Bear Tooth	Q		7 N.	7 E.		See text this report
Beaudry (Bazet)	P	28, 29, 32, 33	35 N.	8 W.	Estate of Angele Bazet, 4 Laguna St., San Francisco	XIV, p. 901; XXII, pp. 34-35. See text this report
Bed Rock Tunnel	P	12	34 N.	11 W.	John Burger and others,[5] Dedrick	No published report
Bell Gulch	P	29	33 N.	10 W.	J. A. Gilzean and others, Junction City	No published report
Bergin	P	18 12, 13	33 N. 33 N.	10 W. 11 W.	J. W. Bergin & Lena A. Bergin, Weaverville[5]	See text this report
Big Bar	Coal	5	33 N.	12 W.	Public domain	XIII, p. 56; XIV, p. 878; XXII, p. 13. See text this report
Big Bend	P	17	33 N.	8 W.	J. W. Phillips, Lewiston	XIII, p. 459 (Phillips); XXIX, pp. 58-59
Big Chief	Q	16	8 N.	8 E.	Ladd Bros., Denny	XIV, p. 884
Big Creek	P	7, 8	31 N.	11 W.	Big Creek Placer Mining Co., Oakland	XIV, pp. 901-902
Big Dutchman	P	1	34 N.	9 W.	Mary E. Jackman,[5] c/o U. S. Forest Service, Phelan Bldg., San Francisco	No published report
Big East Fork	P	30, 31	35 N.	10 W.		XIV, p. 902. See Canyon Placers
Bigelow	P	31	32 N.	9 W.	Harvey Bigelow & Pearl Bigelow, Douglas City	XXIX, p. 58
Bigelow	Q	15, 16	34 N.	10 W.		XIV, p. 884
Big Stake	Cr		31 N.	12 W.		U.S.G.S. Bull. 725, pp. 2-4 (map)
Bismarck	Q	12, 13	33 N.	8 W.	I. C. Lewis,[5] 306 14th St., Oakland	No published report
Black Cloud	Q	31, 32	34 N.	9 W.	c/o E. N. Todd, Weaverville	See text this report
Black Crane	Cr	14	38 N.	6 W.	Bud Wagner, Trinity Center	See text this report

Black Crow	Cr	14, 18	38 N.	5, 6 W.	G. L. Costa, Castella, et al.	See text this report
Black Jack	Cr	28	30 N.	12 W.		Bull. 76, pp. 211, 224
Blagrave	Q	8	37 N.	7 W.	Estate of George H. Blagrave, Carrville	No published report
Bloss & McClary	P	5	36 N.	7 W.	Skeys Mining Co., Redding	X, pp. 699-700; XII, p. 307; XIII, p. p. 902
Blue Gravel	P	1	31 N.	11 W.	D. E. Shack	XIV, p. 902
Blue Jacket	Q	17, 18	37 N.	7 W.	Adams Exploration Co.	XIII, p. 439; XIV, p. 884; XXVII, p. 29; U.S.G.S. Bull. 530-D, p. 21
Bluejay	Q	2	33 N.	8 W.	Wm. Collins, Redding	XXIX, p. 11. See text this report
Blue Jay	Q	13	37 N.	8 W.		See New Blue Jay Mining Co.
Blue Jib	P	13	37 N.	8 W.	Graves & Carter	XIV, p. 916
Blue Lead	P	6, 31	33 N.	9 W.	T. I. Woodbury	XIV, p. 902
Boarding House	Q	22	35 N.	8 W.	L. N. Denison, Minersville	No published report
Boeddecker, John	Q	33	38 N.	8 W.		XXII, p. 23
Bonanza	Q	29	35 N.	8 W.	J. H. Tourtellotte, Weaverville	XI, p. 483, XII, p. 307; XIII, p. 439; XIV, p. 885
Bonanza	Q	10	35 N.	11 W.	J. L. Johnson, Helena	XIV, p. 885; XVIII, p. 207
Bonanza King						See United Trinity
Bonton	P	26	34 N.	9 W.	W. D. Carr, Lewiston	No published report
Boomer						See Mountain Boomer
Boston						See Star of the East
Boulder Cons. Gold Mines Co.	Q	7, 8	38 N.	5 W.	Miriam Miller,[5] 468 Locke Haven St., Pasadena	See text this report
Bourier	P	4 28, 33	34 N. 35 N.	8 W. 8 W.	Jos. F. Bourier, 4 Laguna St., San Francisco	No published report
Bower & Matlock	P		31 N.	11 W.	M. M. Bower & James Matlock, Hayfork	XIV, p. 902
Boyd	P	28	8 N.	8 E.	A. Boyd	XIII, p. 440; XIV, p. 916
Brizzard Ranch (Hawkins Bar)	P					XXII, p. 35
Brooks Lode	Q	24	9 N.	7 E.	Percy Grace Estate,[5] c/o W. R. Grace Co., 332 Pine St., San Francisco	No published report
Brown Bear	Q	11, 12, 13, 14, 16, 24	33 N.	8 W.	E. E. Erich, French Gulch[5]	VIII, p. 639; X, p. 713; XI, p. 483; XII, p. 308; XIII, pp. 440-41; XIV, pp. 885-86; XXII, pp. 15-16; XXIX, pp. 13-15; U.S.G.S. Bull. 540, pp. 70-71. See text this report
Brown Dog	Cr	2	38 N.	6 W.	E. Pickering, Trinity Center	See text this report
Brown, M. J.	Asb				Near Altoona Mine	XXII, p. 12
Brown's Bar	P		7 N.	7 E.	Brackett & James Estate	XIV, p. 903
Brown's Mtn.	ls	21 3	33 N. 33 N.	9 W. 10 W.		Bull. 38, p. 94; XIV, p. 920; XXII, p. 62
Brown's Mtn.	SO	21	33 N.	9 W.		Bull. 38, p. 353; XXII, p. 67
Buckeye	P	19	37 N.	7 W.	M. H. McIlwaine, Trinity Center	XIV, p. 917
Buckeye Mining Co.	P	2, etc. 6, etc. 6	34 N. 34 N. 33 N.	9 W. 8 W. 8 W.	c/o R. G. Percy, Minersville[5]	See text this report
Buck	Q	14	32 N.	9 W.	J. W. Phillips, Lewiston	VIII, p. 643; XIV, p. 886
Bully Choop	Q	4, 5, 8, 9	31 N.	8 W.	Deeded to State in 1931	VIII, p. 640; XII, p. 308; XIII, p. 441; XIV, p. 886; XX, p. 182; XXIX, pp. 15-17. See text this report
Burger	P	12, 13	34 N.	11 W.	J. A. Burger	XIV, p. 903
Cacy (Casey)	P	26, 27	32 N.	9 W.	Estate of Dr. D. B. Fields	XIV, p. 903

Footnotes are at end of table.

TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST—Continued

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Calmich (Lappin Lapman)	Q	13	33 N.	8 W.	Mary F. Bacon and others, 60 S. San Rafael Ave., Pasadena	XIV, p. 894; XXIX, p. 17
Camzo	P				F. M. Tyler, R. P. & E. K. Zoller	XXII, p. 35
Canada Hill	P	4	34 N.	8 W.	P. Burr and N. C. Richardson, Lewiston	No published reports
Canyon Placers, Inc.	P	29, 30 1, 12 6, 7	35 N. 34 N. 34 N.	10 W. 11 W. 10 W.	Canyon Placers, Inc.,[5] Dedrick	See text this report
Carlson & Sandburg	P	5	32 N.	9 W.	L. D. Carlson & John Sandburg, Forum Bldg., San Francisco	XXXIV, p. 114
Carr	P	32	33 N.	10 W.	Geo. F. Lewman, Junction City	No published report
Carrie	Q	5	37 N.	12 W.	G. Ferney	XIII, pp. 441-42; XIV, p. 886
Carr, Joseph	P	1	32 N.	10 W.	M. C., H. C. & I. Jordan, Douglas City	No published report
Carrville Gold Co.	P	8, 17, 20, 29	37 N.	7 W.	Edward C. Condon, Pres.,[5] 807 Lonsdale Building, Duluth, Minnesota	See text this report
Caudwell	Mn	21	28 N.	11 W.		Bull. 76, pp. 89, 90; XXII, p. 63
Cedar Camp	Cr	10	29 N.	11 W.	Fred Werseen, Igo	See text this report
Cement & Mule Creek	P	30, 31, 32	35 N.	8 W.	Wm. E. Stewart, Weaverville[5]	XIV, p. 903
Chamberlain & Red Hill	P	13 18	33 N. 33 N.	9 W. 8 W.	Elsa A. Chenoweth,[5] 317 S. Hill St., Los Angeles	X, pp. 708-09
Champion	P				C. Bradbury & John Hagleman, Junction City	XVII, p. 543
Champlain	P	7, 18	33 N.	9 W.	C. Bradbury & Theresa M. McDonald, Junction City	No published report
Chanchelulla	Q	1	30 N.	10 W.	David Boyer and others, Ono	XXIX, p. 18
Chapman	Q	33	38 N.	8 W.	W. Chapman	XIV, p. 886
Chapman & Fisher	P, Pt	19, etc.	33 N.	10 W.	Estate J. S. Sheridan,[5] c/o Wm. J. Dryden, 760 Haight St., Alameda	X, p. 708; XIII, p. 442; XIV, p. 903; XXII, p. 64; Bull. 85, p. 84
Chiksan Oil Co.						See Enterprise
China Bar	P	17	33 N.	6W.(?)	G. J. Scannell & S. Sorenson, 529 First National Bank Building, Oakland	No published report
Chloride	Q	21(?)	35 N.	10 W.	Roy Rosenbush, Dedrick	See text this report
Chrome No. 2	Cr	3(?)	36 N.	6 W.	S. W. Massey, Oakland	See text this report
Cinco Mineros Co.	P	7, 8	31 N.	11 W.	C. E. Cummings, Pres., Box 212, Oroville	See text this report
Clement	P	29	32 N.	9 W.	C. E. Clement, Douglas City	No published report
Clayton	P	7, 8	33 N.	8 W.	Samuel Williams, Lewiston	No published report
Cleveland	Q	4, 9, 16	31 N.	8 W.	C. F. Foster Co.,[5] Box 266, Corning	XII, p. 310; XIII, p. 442; XIV, p. 887; XXIX, pp. 18-19
Clover	P	12	37 N.	8 W.	A. M. Daly	XIV, p. 903
Colby & McIlwaine	P	16, 20, 21	38 N.	9 W.	C. H. Colby & M. H. McIlwaine, Trinity Center	No published report
Compass	Cr	21	30 N.	12 W.		Bull. 76, p. 211
Comstock	P	32	36 N.	7 W.	Fred Giddings,[5] P.O. Box 3088, Honolulu, T. H.	No published report
Consolidated	P	26	32 N.	9 W.	Estate of F. R. Duarte and others, Douglas City	No published report
Coro	P	14	36 N.	8 W.	Coro Gold Mining Corp.,[5] c/o H. H. Coffee, Trinity Center	See text this report

Corono	P, Pt	17, 18	6 N.	6 E.	Corono Mining Co., c/o Philip Bruce, 690 Fifth St., Eureka	XIV, p. 904; Bull. 85, pp. 89-90; XXII, pp. 45, 65
Corono de Oro						See Corono
Costa	P	21	34 N.	9 W.	Mrs. Jesse Costa,[5] Weaverville	XXII, p. 35. See text this report
Coumbs, Wallace & Ingram	P	31	32 N.	9 W.	Harvey Bigelow	No published report
Craig						See Mason & Thayer
Crofton	P	32	34 N.	9 W.	A. A. Junkans,[5] 107 Oakdale Ave., Mill Valley; L. Todd, Dunsmuir	No published report
Crow Creek	Cr	14	38 N.	6 W.		Bull. 38, p. 272; Bull. 76, p. 210; XIV, p. 877; XXII, p. 12. U.S.G.S. Bull. 725, p. 2-4 (map no. 30)
Curley	P	1	31 N.	11 W.	W. Leach	XIV, p. 904
Daisy						See Hilliard
Daisy	Q	5	33 N.	8 W.	H. S. Blakemore	XIII, p. 443
Dannenbrink	P	12, 13, etc.	35 N.	10 W.	See Canyon Placers, Inc.	XIII, p. 444; XIV, pp. 902, 904, 906, 912; XVIII, p. 601; XIX, p. 59; XXII, p. 35
Dawn of Hope	Q	6	32 N.	10 W.	Mrs. M. M. Knapp, Redding	See text this report
Deer Lick	MS	6, 7	30 N.	9 W.	Calif. Medicinal Springs Co.,[5] 22 Cliff St., New York, N. Y.	XXII, p. 63; U.S.G.S. Water Supply Paper 338, pp. 261-263
Democrat	P	13, 24	33 N.	10 W.	A. C. Meckel, Weaverville	See text this report, XVII, p. 543
Democrat	Q	12, 13	33 N.	10 W.	D. E. Ryan and others, Weaverville	XXII, pp. 17-18; XXIX, pp. 20-21
Dixie Queen	Q	14, 23	32 N.	9 W.	Melvin A. Taylor, 809 8th Ave., Oakland	XIV, p. 887; XXII, p. 17; XXIX, p. 21
Dock & Kise	P	17	33 N.	8 W.	H. B. & L. M. Lister, 805 Pacific Bldg., San Francisco	No published report
Dodge Ranch	Cr					Bull. 76, p. 210
Dolly Varden	P	9, 16	33 N.	10 W.	A. A. & F. A. Schaffer, Junction City	XIV, p. 904
Dorleska	Q	17, 20	37 N.	9 W.	Henry Carter, c/o Oliver Carter, Redding	XXII, p. 18; XXVII, p. 32. U.S.G.S. Bull. 530-D, pp. 34-35. See text this report
Douglas City	P	1, 12 6, 7	32 N. 32 N.	10 W. 9 W.	Estate of Dr. D. B. Fields, c/o Mrs. Honora B. Fields, Weaverville	XXIX, p. 61
Drake	Cr		30 N.	11 W.		U.S.G.S. Bull. 725, pp. 2-4 (map)
Drinkwater	P	13, 24	31 N.	12 W.	Drinkwater Mining Co., Oakland	XIV, p. 904
Driver	P	15	33 N.	10 W.	G. D. Young	XIV, pp. 904-05
Dry	P	25	32 N.	9 W.	H. A. & Wm. Morris,[5] Douglas City	No published report
Eagan's Flat	P	1, 12	33 N.	11 W.	I. W. Perry, c/o R. Perry, Mills Bldg., San Francisco	No published report
East Fork	P	1, 2, 11, 12	36 N.	7 W.	M. McIlwaine and others	XIV, p. 905
Eastman	P	33, 34	34 N.	8 W.	J. W. Martin, Lewiston[5]	XIII, p. 451; XIV, p. 905; Bull. 92, p. 95
Eastman Con						See Venecia
Ehrman	P	18	33 N.	8 W.	John Caton, Redding	No published report
El Dorado						See Bergin
Elevator	P	31, 32	40 N.	6 W.	J. Dodge & S. Wilbur, Carrville	No published report
Ellston	P	7	36 N.	12 W.	R. Ellston	XIV, p. 917
Empire	Cr	31	30 N.	12 W.	Alvis Rais, et al., Forest Glen	See text this report
English Tom	P	8	33 N.	8 W.	Trinity River Mining Co.,[5] c/o S. C. Haight, 2337½ Haste St., Berkeley	See Trinity River Mining Co.
Enterprise	Q	29, 32	35 N.	11 W.	Chiksan Oil Co.,[5] Fullerton	VIII, p. 643; X, p. 710; XI, p. 482; XIII, pp. 446, 454; XIV, pp. 887-88; XVIII, p. 207; Pre. Rep. No. 8, p. 18; XXII, pp. 18-19. See text this report
Estabrook Gold Dredging Co.	P	4, 5 29, 33	36 N. 37 N.	7 W. 7 W.	See Shasta Hydraulic Gold Co. and Carrville Gold Co.	XIV, pp. 918-19; XVIII, pp. 258, 297, 601, 735-36; Bull. 36, p. 104. U.S.G.S. Bull. 540, p. 19

Footnotes are at end of table.

TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST—Continued

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Eureka	Cr	18	30 N.	12 W.		Bull. 76, pp. 211-12
Eureka	Q	33	35 N.	10 W.	Maple Creek Mining Co., Weaverville	XIV, p. 888
Evans Bar	P	32	33 N.	10 W.	Carr Bros.	X, p. 707; XIII, p. 446; XIV, p. 905
Excelsior	Q	9	31 N.	8 W.		XIII, p. 446
Excelsior	Q	5, 8	37 N.	12 W.	Harris & Colegrave	X, p. 715; XIII, p. 446; XIV, p. 888
Ext. Blue Jay	Mn	16, 17	26 N.	12 W.	J. M. McKnight, Scotia	See text this report
Fairview	Q	3, 10, 11	34 N.	8 W.	Fairview Mining Co., Room 1204, Russ Bldg., San Francisco[5]	XIV, p. 888; XXIX, pp. 23-24; U.S.G.S. Bull. 540, pp. 75-76. See text this report
Federal	Cr	4, 6	1 S.	7 E(?)		Bull. 76, p. 212
Fields-Meckel	Q	15, 21	34 N.	10 W.	See Meckel-Fields also	XXII, pp. 19-20; XXIX, pp. 24-25
Fisher Gulch	P	1 36	34 N. 35 N.	11 W. 11 W.	P. H. Jensen, Junction City	XI, p. 483
Five Pines	Q	19, 20, 29	35 N.	7 W.	Lester Van Ness and others, French Gulch	XIV, p. 889; XVIII, p. 355; Pre. Rep. No. 8, p. 18; XXII, p. 20; XXIX, pp. 25-26. U.S.G.S. Bull. 540, pp. 73-74
Florence						See Phillips
Foggarty & King	Cr		30 N.	11 W.		U.S.G.S. Bull. 725, pp 2-4 (map)
Forget Me Not	Q	8, 9	37 N.	7 W.	Mary J. Carr, Carrville	XIII, p. 446; XIV, p. 889
Foster & Cuff	Cr		31 N.	12 W.		U.S.G.S. Bull. 725, pp. 2-4 (map)
Foster						See Cleveland
Fountain Head	Q	4	34 N.	11 W.	R. Ellson	XIII, p. 447; XIV, p. 889
Four Point	Q	32	35 N.	10 W.	H. C. Stofer and others, Helena	XIV, p. 889
Fowler					F. A. Fowler	XXII, p. 35
Freethy	P	28, 29	36 N.	7 W.	W. F. Detert, 995 Market St., San Francisco	No published report
French Bar	P	29, 30	5 N.	8 E.	French Bar Mining Co., c/o W. F. McClure, Del Loma	See text this report
Garden Gulch	P	1, 12 36	33 N. 34 N.	10 W. 10 W.	Mrs. M. L. Woodbury, Weaverville	XIV, p. 905
Gem	P	13	6 N.	5 E.	Gus Perigot, Blue Lake	XIV, p. 905; Bull. 85, p. 89
Geneva-Trinity	P	6	33 N.	12 W.	Geneva-Trinity Mining Co.	See text this report
Gifford	Q	3	33 N.	8 W.	J. F. Gifford, Lewiston	XVIII, p. 497
Gilzean	P	18	33 N.	10 W.	J. A. Gilzean and others, Junction City	No published report
Globe	Q	15, 16, 21	35 N.	10 W.	Gilzean Bros., Junction City	X, pp. 711-12; XI, p. 483; XII, pp. 310-311; XIII, pp. 442, 447; XIV, pp. 889-91; XVII, p. 540; XXII, pp. 20-21; XXIX, p. 28; U.S.G.S. Bull. 540, pp. 76-78. See text this report
Goat Camp	Mn	35, 36	29 N.	11 W.	W. O. Friend, et al., Hayfork	See text this report
Gold Bar Dredge	P	18, 19 13	33 N. 33 N.	8 W. 9 W.	See Lewiston Gold Dredging Company	XXIX, p. 62
Gold Dollar	P	19, 24	34 N.	11 W.	Mary O'Neill, W. A. Day, and others, Weaverville	No published report
Gold Dollar	P	33	33 N.	9 W.	Verne E. Bonneau (?), c/o F. T. Van Atta, Mill Valley[5]	XIV, p. 906
Golden Bow	Q	4	34 N.	8 W.	G. B. Reed, Box 71, Shasta	No published report
Golden Chest	Q	9	35 N.	11 W.	J. L. Johnson, Boyce and others, Helena	VIII, p. 641; X, p. 711; XIII, p. 447; XIV, p. 891

Golden Eagle	P	28	36 N,	7 W.	W. C. Sharpsteen,[5] 898 Mills Bldg., 220 Montgomery St., San Francisco	No published report
Golden Gravels	P	33, 34	34 N.	11 W.	Golden Gravels Mining Co.,[5] G. W. Hassler, Mgr., Helena	See text this report
Golden Jubilee	Q	4	37 N.	8 W.	McCormick-Saeltzer Co.,[5] Redding	XIV, p. 891; XVII, p. 540; Pre. Rep. No. 8, p. 18; XXII, pp. 21-22; XXVII, pp. 37-40. U.S.G.S. Bull. 530-D, p. 27. See text this report
Golden King	Q	28(?)	9 N.	7 E.	c/o Chas. A. Mitchell, Lewiston	See text this report
Golden Star	Q	2	33 N.	10 W.	B. R. Brown and others, Weaverville	No published report
Goldfield Con. (Jacobs, Red Hill)	P	1, 2 35, 36	33 N. 34 N	11 W. 11 W	Goldfield Consolidated Mines Co., 1225 Crocker First Nat. Bank Bldg., San Francisco	XXII, p. 38. See Northern California Mines Co. also See text this report
Gold Leaf	Q					XII, p. 311; XIII, p. 447; XVIII, p. 298
Gold Ridge	P	1 36	33 N. 34 N.	10 W. 10 W.	Estate of W. H. Martin, J. W. Tinnin, c/o M. Martin, Weaverville	No published report
Good Friday & Red Sunday	P	19, 20	33 N.	10 W.	Estate of T. C. Post	X, p. 708; XII, p. 311; XIII, p. 447; XIV, p. 912
Graf Group	P	13 18	33 N. 33 N.	11 W. 10 W.	See Junction City Min. Co. and Bergin	X, p. 704; XII, p. 308; XIII, p. 443. (Compagnie Francaise)
Graig	Q	4	34 N.	11 W.	Wm., John and James Meredith and others	No published report
Grand National	Q	30 25	39 N. 39 N.	7 W. 8 W.	Grand National Mining Co.,[5] c/o A. F. Stone, Callahan	See text this report
Grass Valley Creek	Mo	31	33 N.	8 W.		XXII, p. 63
Graves	P	29, 30	37 N.	7 W.	Trinity Exploration, Carrville	XIV, p. 917
Green Stripe	Cr	8(?)	38 N.	6 W.	George L. Costa, Castella	See text this report
Gribble	P	8, 9	33 N.	10 W.	Richard Gribble,[5] Junction City	XII, p. 311; XIII, p. 448
Gunther	P	36	31 N.	11 W.	E. J. Gunther and others,[5] Hayfork	See text this report
Gypsie Queen	Q	23	38 N.	9 W.	Leone Conant and others, Redding	See text this report
Hager & Haas	P	7, 18 12	33 N. 33 N.	10 W. 11 W.	Abrahms,[5] Karsky, and C. H. Edwards Estate, c/o Eleanore C. Edwards, Weaverville, or 595 Mission St., San Francisco	See Junction City Mining Co.
Hammer	Pt				See South Fork and Swanson	XXII, p. 65; Bull. 85, pp. 86-87
Hang Bar	P	36	31 N.	11 W.		XIV, p. 906
Hansen, E. E.	P	19, 29, 32, 34	34 N.	9 W.	M. Zanovich	XIII, p. 448
Happy Home	P	30	35 N.	10 W.	Consolidated with Dannenbrink	XIV, p. 906
Hardscrabble	Q	15	38 N.	9 W.	John Keating & Ann Edwards, c/o Scott Valley Bank, Etna Mills	U.S.G.S. Bull. 530-D, p. 35
Hardtack	Q	6	37 N.	12 W.	T. J. Ladd	XIII, p. 448; XIV, p. 892
Hard Times	Q	6	37 N.	12 W.	E. C. Miller	XIII, p. 448; XIV, p. 892
Harmon & Allen	P	11, 13	33 N.	10 W.	Estate of J. W. Meckel,[5] A. C. & Louisa Meckel, Weaverville	See Democrat Gulch
Harold	P	25, 26, 34, 35	35 N.	8 W.	Harold Min. & Dev. Co., c/o G. O. Hunter, 331 Douglas Bldg., Los Angeles	No published report
Hart, Turner & Adams	Cr		29 N.	10 W.		U.S.G.S. Bull. 725, pp. 2-4 (map)
Haskins	P	5	36 N.	7 W.	F. Petra	X, pp. 698-99; XIII, pp. 448-49; XIV, p. 906
Haunted Bar	P				J. L. Mushick	XIV, p. 917
Hawkins Bar	P Pt	20, 21 28	6 N.	6 E.	Eleanore I. Holcombe,[5] Hillside Ave., Mill Valley	XIII, p. 449; XIV, p. 907; Bull. 85, p. 89
Hayfork						See Mueller
Hayfork Creek	P					XXII, pp. 48-49

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TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST—Continued

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Hayfork Dredge	P	12	31 N.	12 W.	Hayfork Gold Dredging Co., Hayfork	XXXIV, p. 116. See text this report
Hayfork Valley	Coal					XII, p. 62; XIV, p. 877; XXII, p. 13
Hayward	P	25 30	5 N. 5 N.	7 E. 8 E.	Estate of Carrie Hayward,[5] Big Bar	See text this report
Hazel	P	14	32 N.	8 W.	Hazel Gold Mining Co., San Francisco	No published report
Headlight	Q	20, 21	37 N.	7 W.		XIII, p. 449; XIV, p. 892; XXII, pp. 22-23; XXVII; p. 43. U.S.G.S. Bull. 530-D, pp. 17-21
Headstrom	Q	9, 16	37 N.	7 W.	C. L. Headstrom, Carrville	No published report
Henderson	P	13	6 N.	5 E.	Henderson & Ferguson	XIV, p. 907; Bull. 85, p. 89
Heninger	P	35	38 N.	9 W.	Heninger Bros.,[5] Carrville	XXII, p. 36. See text this report
Henry Clay	Q	11	33 N.	8 W.	H. R. Anderson,[5] c/o M. M. Getz, Flood Building, San Francisco	XIII, p. 447. See text this report
Hidden Treasure	Q				14 mi. N. Helena	XXII, p. 23
Hidden Treasure	P				J. B. McDonald	XIII, p. 449; XIV, p. 917
Highland	P	25	5 N.	7 E.	Highland Mining Co.,[5] c/o Rose L. Chaplain, Red Bluff	No published report
Highland Lake	Cr	2	37 N.	6 W.		Bull. 76, p. 210; XXII, p. 12
Hill Crest	P	17	33 N.	10 W.	A. A. & F. A. Schaffer, Junction City	No published report
Hilliard & Daisy	P	13, 24	31 N.	12 W.	Anna Van Gordon Kergan,[5] and others, c/o Geo. Van Gordon, Damville	No published report
Hindley	P	5, 6	33 N.	9 W.	F. Showalter,[5] Maude H. Hupp, 823 West Bridge St., Phoenixville, Calif.	No published report
Hocker	P	1, 2	33 N.	11 W.	Goldfield Cons. Mines Co.,[5] and others, 1225 Crocker First Nat. Bank Bldg., San Francisco	No published report
Hodges	P	12	38 N.	9 W.	W. L. Hodges, Coffee	No published report
Hoelling	Cr	20, 21	1 N.	8 E.	Henry W. Hoelling, Hayfork	See text this report
Holland	P	16, 17	38 N.	8 W.	P. H. O'Connor,[5] J. L. Coyle, c/o Richstrike Gold Mines, Stock Exchange Bldg., Vancouver, B. C.	XXII, pp. 45-48; XXVII, pp. 58-60
Hook & Ladder	P	5, 6	33 N.	9 W.	W. H. LaBaree,[5] and others, 2201 Glen Ave., Berkeley	XIV, p. 907; XXII, pp. 36-37; XXIX, pp. 62-63
Horseshoe & Homestake	P	18	33 N.	9 W.	Wm. B. Testy, 729 Main St., Vallejo; C. J. Testy, Weaverville	XIV, p. 907
Horseshoe Bend						See Swanson
Howard & Campbell	P	5	33 N.	12 W.	S. M. Campbell, R. D. Howard, Big Bar	XXII, p. 37
Humboldt	P	5, 6	34 N.	8 W.	Humboldt Placer Min. Co., c/o M. J. Curless, Blocksburg	XIV, p. 912; XXII, pp. 37-38; XXIX, pp. 67-68 (Majestic). See Buckeye in text this report
Hunter	Q				J. P. Hennessy	XIII, p. 450; XIV, p. 893
Hupp	P				At Weaverville	U.S.G.S. Bull. 470, p. 25
Hyampom Valley	Coal					XII, pp. 62-63; XIV, p. 877; XXII, p. 13
Hydraulic Hill	P	32	34 N.	11 W.	The Lorenz Co., c/o Mrs. A. Meininger, Redding	XIV, p. 907
Index	Q	28	7 N.	7 E.	John & J. E. Larsen, Sawyers Bar	Pre. Rep. No. 8, p. 18
Indian Creek	P	23, 26	32 N.	9 W.	Estate of Dr. D. B. Fields, c/o Mrs. Honora B. Fields, Weaverville	XIV, p. 907; XXII, p. 38; XXIX, pp. 63-64; U.S.G.S. Bull. 470, p. 20. See text this report
Indian Creek	P	5, 8	32 N.	9 W.	Manuel C. DeReis, Douglas City	See Carlson & Sandburg

Ingleside	P	27, 28	35 N.	8 W.	G. A. Steward	XIII, p. 450
Integral	Cr	23	38 N.	6 W.	Zack Anderson, Box 162, Middletown, Lake County	Bull. 76, pp. 210-11; XXII, p. 12; U.S.G.S. Bull. 725, pp. 2-4 (map). See text this report
Integral	Hg	15, 22	38 N.	6 W.	Zack Anderson,[5] Box 162, Middletown, Lake County	XII, p. 372; XIII, p. 604; XIV, p. 924; Bull. 27, pp. 193-195; Bull. 78, p. 202; XXII, pp. 66-67. See text this report
Interstate	P	28	33 N.	9 W.	Interstate Mines, Inc., J. C. Hamilton, Mgr., Box 498, Chico	See text this report
Iron Dike	Q	18	37 N.	7 W.	Mrs. Mary J. Carr, Carrville	U.S.G.S. Bull. 530-D, p. 24
Isabel	Q	32	35 N.	10 W.	T. E. Martin	XIV, p. 893
Island Copper	Cu	9	5 S.	6 E.	Island Copper Co., E. R. Leach, Pres., 214 Hillside Ave., Piedmont	Bull. 50, pp. 148-50; XIV, p. 881; XXII, pp. 14-15
Ivy Gulch	P	3	33 N.	12 W.	Mrs. Julia Ivy, Helena	XXII, p. 38
Jack Tar	P	2	33 N.	10 W.	Edw. Meckel & John Haley, Weaverville	No published report
Jacobs						See Goldfield Consolidated
Jacoby	Q		33 N.	9 W. (?)	Goodyear & Richards	XIV, pp. 893-94
Jennings Gulch	P				Jennings Gulch Mining Co.	XVIII, p. 450; Bull. 92, p. 95
Jerusalem	Q	9	31 N.	8 W.	J. T. Lockhard	XIII, p. 450; XIV, p. 894
Johnson	Mn	9, 10	28 N.	11 W.		Bull. 76, p. 90; XXII, p. 63
Johnson Point	P	4	32 N.	10 W.	Geo. F. Lewman,[5] Junction City	No published report
Jones Bros.	Asb	7	37 N.	7 W.	Jones Bros. Asbestos Supply Co., 370 2d St., San Francisco	XXVII, p. 26
Joss	P	7, 18	33 N.	9 W.	H. S. Lowden, Weaverville	XIV, p. 908
Joy	P	1, 12 31	30 N. 31 N.	10 W. 9 W.	Russell T. Joy, 604 Mission St., San Francisco	No published report
Jumbo						See Golden King
Junction City	P	1 18	33 N. 33 N.	11 W. 10 W.	Junction City Mining Co.,[5] Harvey Sorensen, Pres., 685 6th St., San Francisco	XXXIV, pp. 117-18. See text this report
Just in Time						See Democrat Gulch
Katie Foley	P	10	37 N.	7 W.	F. C. Potter and others, c/o Harrington, 308 Montgomery St., San Francisco	No published report
Keating	Q					XXII, p. 23
Kelly	Q	20(?)	31 N.	11 W.	T. C. Kelly,[5] Hayfork	See text this report
Keno	Q	19	35 N.	7 W.	Estate of C. W. & Nora V. Thrasher, G. M. Van Ness, O. P. Ormsby, B. F. Rogers,[5] Route 1, Gridley	No published report
Keystone	P				C. A. Austin, Denny	XIII, p. 452
King Hydraulic	P				H. King, et al., Big Bar	XIV, p. 908
Koon	P Pt	23, 24 25, 26	6 N.	5 E.	John A. & Myrtle H. Koon, Salyer	Bull. 85, p. 88; XXII, p. 39
La Clair	Q	13, 24	35 N.	8 W.	L. E. Van Ness and others, French Gulch	XXIX, p. 33
Ladd	P		7 N.	7 E.	Grover H. & W. Ladd, Denny	No published report
La Grange	P	3, etc.	33 N.	10 W.	La Grange Placer Mines, Ltd.,[5] c/o Dr. Lyman Stookey, Weaverville	VIII, p. 638; X, p. 702; XII, p. 311; XIII, pp. 452-53; XIV, p. 908; XVIII, p. 257; XX, p. 182; Bull. 92, p. 94; XXII, pp. 39-43; U.S.G.S. Bull. 470, pp. 16, 25. XXIX, pp. 64-65. See text this report
Lappin (Lapman)						See Calmich
Larsen	P				Larsen Bros.	XIV, p. 909
Lary	Q	11	33 N.	8 W.	E. L. McConnell, Box 152, Castella	See text this report

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Footnotes are at end of table.

TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST—Continued

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Last Chance						See Montezuma
Last Chance	Q	2	33 N.	8 W.		XIV, p. 894
Laurel (Phillips)	Q	14	32 N.	9 W.	J. W. Phillips, Lewiston	XIV, p. 894; XVII, p. 541; XXIX, p. 44
Laws	P	13 18	33 N. 33 N.	11 W. 10 W.	Lena A. Bergin	See Bergin
Layman	Q					XIV, p. 894; XVIII, pp. 207, 600. See Mueller also
Lewiston Dredge	P	21, etc.	34 N.	8 W.	M. L. Requa	XVIII, pp. 139, 297, 601, 733; Bull. 92, p. 94; Pre. Rep. No. 8, p. 18; XXIX, pp. 65-66. U. S. Bureau of Mines, I. C. 6660
Lewiston Gold Dredging Co. (Gold Bar)	P	18, 19	33 N.	8 W.	Lewiston Gold Dredging Co., C. H. Thurman, Mgr., 960 Russ Bldg., San Francisco	XXIX, p. 62; XXXIV, p. 118. See text this report
Liberty	Q	4	37 N.	8 W.		XXII, pp. 23-24
Liberty Bell	VO	13	34 N.	8 W.		XVII, p. 544; XXII, p. 67
Lila	Q	12	33 N.	8 W.	T. E. Thurner & Gruss Estate, 1130 Chestnut St., Chico	XXIX, p. 34
Lincoln Dredge	P	27(?)	33 N.	9 W.	Lincoln Gold Dredging Co., c/o W. K. Jensen, Lincoln	See text this report
Linda Marie	P	32, 33	1 S.	8 E.	C. H. Mathews, Forest Glen	XVII, p. 543
Lister	P	17	33 N.	8 W.	H. B. & L. M. Lister, 805 Pacific Bldg., San Francisco	No published report
Little Alice (Little Annie)						See R. A. M.
Little Ann	Cr	30	31 N.	12 W.	Delmar E. Frye, Hayfork	See text this report
Little Buster	Q				Frank Gallaher, Lewiston	XVII, p. 540
Little Creek	P	31	32 N.	12 W.	Asa Drake, Hayfork	No published report
Little Joe	P	25	32 N.	9 W.	Amelia Williams,[5] Douglas City; A. V. Stebbins, Douglas City	XIV, p. 909
Log Cabin	P	33	32 N.	9 W.	Wm. O. Wallace, Douglas City	See Reddings Creek Placer, Ltd.
Log Cabin Bar	P		7 N.	7 E.	F. Staley	XIV, p. 909
Long	P	13	33 N.	10 W.	W. W. Armentrout, Weaverville	No published report
Long Gulch	P	17	35 N.	8 W.	F. Beaudry Estate	XIV, p. 909
Lorenz	P	18, 19 13	33 N. 33 N.	9 W. 10 W.	See Oro Trinity Dredger Co.	XVIII, pp. 97, 207, 257; XIX, p. 139; XX, p. 182; Pre. Rep. No. 8, p. 17; Bull. 92, p. 94-95; XXII, pp. 42-43; XXIX, pp. 66-67
Lost Dog	Cr	34(?)	31 N.	12 W.	Alvin Cottrill, Redding	See text this report
Lost Horse	Cr		32 N.	12 W.		U.S.G.S. Bull. 725, pp. 2-4 (map)
Lost Horse	Q	4	37 N.	7 W.	Geo. W. Elliott, Carrville	XXVII, pp. 43-44
Lower Buckeye	P	19, 29, 30	37 N.	7 W.	Trinity Gold Mining Co.	XIV, p. 909
Lower Dutton's Creek		26, 35	33 N.	10 W.	G. C. Lorenz and others, Weaverville	XIV, p. 909
Lucky Mack						See Bower & Matlock
Lucky Strike	P				C. Schwelder	XIV, p. 917
Lucky Strike & Effie Belle	P	13, 14 23, 24	33 N.	10 W.	See Democrat Gulch	XIV, p. 910; XVII, p. 543
MacNamara						See Nash
Mahoney & Wallace						XII, 312; XIII, p. 455
Majestic	P		34 N. 34 N. 35 N.	8 W. 9 W. 9 W.		XXIX, pp. 67-68. See text this report. See Buckeye Mining Co. also

Maltos, Green & Volente	Cr					U.S.G.S. Bull. 725, pp. 2-4 (map no. 30)
Manuel & Santos	P	19	33 N.	8 W.	C. H. Edwards and others, Weaverville	No published report
Maple	Q	1(?)	34 N.	11 W.		XII, p. 312; XIII, p. 455; XIV, p. 894. See text this report (possibly a different mine)
Maple Creek	P	4, 5, 6	32 N.	10 W.	Maple Creek Mining Co., San Francisco	XIV, p. 910
Marcellus	Q	32(?)	38 N.	9 W.	F. A. Marcellus, Hanford	See text this report
Maringer	Cr	34(?)	31 N.	12 W.	Frank Maringer, Redding	See text this report
Martin	P	24, 30	34 N.	9 W.	Estate of W. H. Martin, c/o M. Martin, Weaverville	No published report
Mason & Thayer	Q	33(?)	35 N.	10 W.	J. B. & F. J. McCauley, 524 Gough St., San Francisco	XXII, p. 16; XXIX, p. 36
May Blossom	Q	16	34 N.	8 W.	Joseph & George Kapusta, Lewiston	XVII, p. 40
McAtee Bar	P		7 N.	7 E.	C. S. McAtee	XIV, p. 910; Bull. 92, p. 93
McClaren	Q	10	35 N.	11 W.	W. J. McClaren, Helena	XXII, p. 24. See text this report
McDonald	P				Estabrook Gold Dredging Co., Trinity Center	XVII, p. 543
McDonald, J. A.	P					XXII, p. 38
McGillivary	P	26, 27, 34, 35	34 N.	11 E.	W. H. Metson, G. O'Shay, and others, Junction City	X, p. 706; XIII, p. 455
McIlwaine	P	16, 22, 27	38 N.	9 W.	M. H. McIlwaine, Trinity Center	No published report
McKay & Abbott	Cr		1 N.	8 E.		U.S.G.S. Bull. 725, pp. 2-4 (map)
McKnight & Kindred	Mn		4 S.	6 E.		Bull. 76, p. 91; XXII, p. 63
McMurray & Hupp	P	7	33 N.	9 W.	Verne E. Bonneau,[5] c/o F. T. Van Atta, Mill Valley	VIII, p. 638; X, p. 701; XII, p. 312; XIII, p. 455; XIV, p. 915
Meckel	P	13, 14	33 N.	10 W.	J. W., A. C. & Louisa Meckel, Weaverville	XIV, p. 910. See Democrat Gulch also
Meckel	P	36(?)	34 N.	10 W.	A. C. Meckel, Weaverville	XXIX, p. 68
Meckel-Fields	Q	15, 21	34 N.	10 W.	A. C. Meckel and others, Weaverville	See text this report
Mike Smith	P	19, 30	33 N.	9 W.	W. H. Leach, Weaverville	No published report
Mineret	P	2	33 N.	10 W.	H. D. Weinheimer,[5] Weaverville	No published report
Minersville	P	22, 27	35 N.	8 W.		XII, p. 312; XIII, p. 455
Mines Exploration Company						See Brown Bear
Modoc	Q	31	9 N.	7 E.	G. W. Healey	XIII, p. 456; XIV, p. 895
Modoc Gold (Wagner)	Q	34 3	38 N. 37 N.	8 W. 8 W.	E. A. Wagner and others,[5] Carrville	U.S.G.S. Bull. 530-D, p. 28. See text this report
Molitor	P	33	37 N.	11 W.	Farnsworth Bros., Cecilville	See text this report
Monarch	Q	18	36 N.	9 W.	J. B. Morrison and others, Los Angeles	No published report
Monk	P	5	32 N.	9 W.	W. Brannan	XIV, p. 910
Monte Christo & Apple Tree	P	1	34 N.	11 W.	Manuel Machada, Dedrick	No published report
Montezuma	P	1, 2, 11, 12	33 N.	11 W.	Jafet Lindeberg,[5] c/o Northern Calif. Mines Co., Inc., 1225 Crocker First Nat. Bank Bldg., San Francisco	XIV, p. 911; XXII, p. 43
Montezuma	Q	12, 13	33 N.	8 W.	Niagara Summit Mining Co.,[5] c/o W. D. Tillotson, Redding	See Vermont in text this report. No published report
Morning Star	Q	31	38 N.	9 W.	Deeded to State in 1937[5]	No published report
Morning Star	Q	3	34 N.	11 W.	Jos. Walter,[5] 365 E. 7th Ave., Vancouver, B. C.	No published report
Morris	P	19 24	4 N. 4 N.	7 E. 6 E.	H. W. Brannan and others, Burnt Ranch	No published report
Morrison Gulch	P	12, 13, 14	37 N.	8 W.	State of California	No published report
Morris, Wm.	P	25	32 N.	9 W.	William Morris and others	XIV, p. 916
Mountain Boomer	Q	19(?)	37 N.	12 W.	Ladd Bros., Denny	X, p. 715; XIV, p. 895; Bull. 92, p. 93. See text this report
Mouth of Weaver	P	6	32 N.	9 W.	I. T. & L. W. Cruthis, Douglas City	See Weaver Dredging Co.
Mueller, (Hayfork, Layman)	Q	20	31 N.	11 W.	Mueller Estate and others,[5] c/o O. R. Mueller, Weaverville	XIV, pp. 892, 894; XVIII, pp. 207, 600. See text this report

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Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Mumbo Creek	Cr	4 or 11	38 N.	6 W.		Bull. 76, p. 211; XXII, p. 12
Mumsie A.	Cr	30	31 N.	12 W.	California B. Frye, Hayfork	See text this report
Munko	Cr	14	38 N.	6 W.	Philip C. Munko, Castella	See text this report
Naphis Peak	Mn				3 mi. NE. Kekawaka, Wm. Pitt White Estate Co.(?), c/o Willis C. White, Alderpoint	Bull. 76, p. 90, XXII, p. 63
Nash	P	6, 7 30, 31	37 N. 38 N.	9 W. 9 W.	Estate of J. L. Joseph,[5] et al., c/o Mrs. E. S. Joseph, 182 Commonwealth Ave., San Francisco	XIII, pp. 464-65; XIV, p. 911; XVIII, p. 6; Bull. 92, p. 95; XXII, pp. 43-44; XXVII, p. 60. See text this report
Negunda	P	12	6 N.	5 E.	H. Zeigler	XIV, p. 917
Nellie May	P	5	33 N.	12 W.	Thos. Treloar,[5] Big Bar	No published report
New Blue Jay Mining Co.	Q	13	37 N.	8 W.	State of California[5]	XIV, p. 885; XVII, p. 541; XXVII, p. 29; U. S.G.S. Bull. 530-D, pp. 36-37
New Discovery	P	16	33 N.	10 W.	A. A. & F. A. Schaffer, Junction City	No published report
New River	Hg	17(?)	37 N.	12 W.	A. Z. Allen, Denny	See text this report
New River	P	13(?)	6 N.	5 E.	Ladd Bros., Denny	XIV, p. 911; Bull. 92, p. 93
New River Co.	P	27(?)	7 N.	7 E.	New River Mining & Development Co., Denny	See text this report
Niedra	Q	33	38 N.	9 W.	R. C. Norton, Carrville	See text this report
Nigger Hill	P	2	32 N.	10 W.	G. Newman	XIV, p. 911
Nonpareil	Q	9	37 N.	7 W.	Strode Bros.	XIV, p. 895
Northern California Mines Co.	P	1, 2 35, 36	33 N. 34 N.	11 W. 11 W.	J. Lindeberg,[5] c/o Northern California Mines Co., 1225 Crocker First National Bank Building, San Francisco	See text this report. See Goldfield Cons. also
North Fork	P	29, 30, 31, 32	34 N.	11 W.	W. P. Anderson, R. L. Chase, c/o H. G. Schlomer, Helena	XXII, p. 45. See text this report
North Star	Q	32 5	35 N. 34 N.	11 W. 11 W.	Estate of R. A. Skinner, Weaverville	VIII, p. 642; X, p. 710; XI, p. 482; XIII, p. 458; XIV, p. 895
North Star	P	17, 20	38 N.	6 W.	C. R. Estes, Alturas	See text this report
Nugget Bar	P	22, 27 4, 5	35 N. 34 N.	8 W. 8 W.	Van Matre heirs	XVIII, p. 496; XIX, p. 140; XX, p. 182; XXII, p. 45
O'Connell	P	33	32 N.	9 W.	William O. Wallace,[5] Douglas City	XIV, p. 911
Old Bill	Mn	9	28 N.	11 W.	T. E. Reynolds, Davis	See text this report
Old Bones (Shock)	Cr		31 N.	11 W.		U.S.G.S. Bull. 725, pp. 2-4 (map)
O'Neill	P	2, 11, 12	33 N.	10 W.	Sam Lee, Weaverville	No published report
Oregon Gulch	P	7, 8	33 N.	10 W.	Richard Gribble, Junction City	No published report
Oriole	Q	25	32 N.	9 W.	Maurice Collins, Douglas City	XIV, p. 896
Oro Corono						See Corono
Oro Grande						See Strode
Oro Trinity Dredge	P	18	33 N.	9 W.	Oro Trinity Dredger Co, R. G. Stapleton & C. E. Cummings, Oroville	XXXIV, p. 119
O'Shay	P	2 35	33 N. 34 N.	11 W. 11 W.		See Goldfield Cons. Mines Co.; also Northern California Mines Co.
Ott, Rudolph	Asb				5 mi. SW. Altoona mine	XXII, p. 12
Overland	Hg				New River District	Bull. 78, p. 202; XXII, p. 67
Ozark	Q	4, 9	34 N.	11 W.	D. G. Reid	XI, p. 482; XIII, p. 459; XIV, p. 896

Pacific Gold Dredging Co.	P				Pacific Gold Dredging Co., Carrville	XVIII, p. 258; Pre. Rep. No. 8, p. 18
Pallestreau	Cr		3 N.	7 E.		U.S.G.S.Bull. 725, pp. 2-4 (map)
Pansy	P	14, 22	36 N.	8 N.	N. S. Dysert, Trinity Center	See text this report
Panwocket						See Indian Creek
Patillo	Q	15, 21	34 N.	10 W.	Estate of Emma A. Miller, Weaverville	XXII, p. 24. See text this report
Paulson & Hughes	P					XII, p. 313; XIII, p. 459
Paulson Hydraulic						See Pickett & Stofer
Paymaster	Q	2	33 N.	8 W.	Estate of P. X. Johnson, c/o Bank of America, Redding; William Richards, et al., Lewiston	XXIX, p. 43. See text this report
Peewee	Cr	21	30 N.	12 W.		Bull. 76, p. 212
Perry	P	1, 30	33 N.	11 W.	I. W. Perry, et al., c/o Raymond Perry, Mills Bldg., San Francisco	No published report
		12	35 N.	11 W.		
Phillips	P	20	33 N.	8 W.	Estates of Lucy F. & Chas. A. Phillips, c/o J. W. Phillips, Lewiston	XIII, p. 459; XXIX, pp. 58-59 (Big Bend)
Phillips						See Laurel
Phillpot	Cr	2	31 N.	12 W.		Bull. 38, p. 272; Bull. 76, p. 211; XIV, p. 877
Picayune	Cr	23	39 N.	6 W.		Bull. 76, p. 211; XXII, p. 12
Pickett & Stofer	P	5, 6	33 N.	8 W.	Chas., H. W., F. R. & A. E. Paulson, Lewiston	XVIII, pp. 97, 257; XIX, p. 139
		36	34 N.	8 W.		
Pine Tree						See Upham
Pink Crystal	Cr	25, 26	38 N.	6 W.	Elmo Pickering, Trinity Center	See text this report
Pittsburg Comstock						See Dannenbrink
Placer Development Co.	P	1	33 N.	11 W.	c/o Bodinson Manufacturing Co., 2401 Bayshore Blvd., San Francisco	See text this report
Plummer Gulch, Nelson Gulch	P	11, 12	36 N.	7 W.	M. H. McIlwaine,[5] Trinity Center	No published report
Poison Camp	Coal	15, 22	2 S.	6 E.		XII, p. 63; XIV, p. 878; XXII, p. 14
Poker Bar	P	24	33 N.	9 W.	Poker Bar Mines Co.	See Interstate in text this report
Pony Bar	P	20, 28, 29	6 N.	6 E.	James J. Irving, Salyer	No published report
Poorboy	Q				4 mi. S. Big Bar. Geo. C. Cottrell, Big Bar	See text this report
Post & Wilson						See Good Friday
Potillo	P	11	33 N.	10 W.	F. Potillo	XIV, p. 911
Pound Cake	Q	8, 9	31 N.	8 W.	H. A. Cotton and others,[5] 207 Borel Ave., San Mateo	No published report
Poverty Flat	P	18, 19	33 N.	9 W.	Lorenz Bros.	XIV, p. 912
Precious Twins	P	17	4 N.	6 E.	Frank Lynch, Hyampom	XIX, p. 94
Price	P	4, 5	33 N.	12 W.	George W. Tinsley, Big Bar	X, p. 709; XIII, p. 460
Prussian & Heimburger	P	12	34 N.	11 W.	J. A. Burger & Lewis Heimburger, Junction City	No published report
Quimby	P	18	6 N.	6 E.	Ferguson & Ziegler	XIII, p. 460; XIV, p. 912
Quimby	Q	22	7 N.	7 E.	Larsen Bros., Sawyers Bar	XIV, p. 896
Railroad & Mt. Morensis	P	9, 15, 16	33 N.	10 W.	La Grange Placer Mines, Ltd.,[5] c/o Dr. Lyman Stookey, Weaverville	X, p. 704; XIII, p. 454; XIV, p. 912
Rainbow	P	33	28 N.	8 W.	Rainbow Mining Co., Carrville	XIII, p. 460; XIV, p. 917-18
Rainbow	Q	32	32 N.	8 W.	Mrs. L. L. Kelley, Fresno	XXII, p. 24; XXIX, p. 45. See text this report
Ralston	Q	32	35 N.	10 W.	G. W. Cordes & F. C. Meckel, Junction City	XIV, p. 897. See text this report
R. A. M. & Little Alice (Annie)	Q	24(?)	34 N.	9 W.	C. H. Foster & James McLaughlin, Redding	XXIX, pp. 45-46
Ray	Q	12	33 N.	8 W.	Danners & Hollensworth	XIII, p. 460; XIV, p. 897
Readjuster	Q	33, 34	34 N.	8 W.	William Richards, Lewiston	No published report
Rebel	Q	31	29 N.	12 W.	Jack Hoffman, Forest Glen	XVIII, p. 92
Red Bank & Banon	P	7	31 N.	11 W.	Thos. Collins, Hayfork	No published report
Red Cliff	Mn	36	25 N.	13 W.(?)		Bull. 76, p. 90; XXII, p. 63

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TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST—Continued

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Redding Creek	Coal					XXII, p. 14
Reddings Creek	P	33	32 N.	9 W.	Reddings Creek Placer, Ltd., 139 N. Virginia St., Reno, Nevada	XXIX, pp. 68-69. U.S.G.S. Bull. 470, p. 20
Red Flat	P	12	34 N.	11 W.	Canyon Placers, Inc.,[5] Dedrick	XIV, p. 912. See Canyon Placers
Red Hill						See Goldfield Cons.
Red Mountain	Cr.	20, 21	26 N.	12 W.	P. A. Pesula, Scotia	See text this report
Reese	Coal	32	32 N.	9 W.	Reese Bros., Douglas City	See text this report
Reindeer	Q	3	37 N.	8 W.	Wagner Mining Co., Berkeley	XIII, p. 461; XIV, p. 897
Ridgeway	Q	6 31	37 N. 38 N.	12 W. 12 W.	Ridgeway Mining Co., Weaverville	X, p. 715; XIII, p. 461; XIV, p. 897
Rising Sun	P	21, 22, 26, 27	34 N.	9 W.	Basil Froloff, Lewiston	XXIX, pp. 69-70
Roe	P	1 31 6	32 N. 33 N. 32 N.	10 W. 9 W. 9 W.	Trinity Cons. Hydraulic Mining Co.	XIV, pp. 912-13
Ruby & Spanish Mike	P	2	33 N.	10 W.	B. R. Brown & Paul Potillo, Weaverville	No published report
Rush Creek	GR					XXII, p. 62
Salmon Summit	Q	23(?)	9 N.	7 E.	Theodore Richardson, 243 Grant St., Eureka	See text this report
Salt Flat	P	13, 23, 24	33 N.	9 W.	Pacifico Fancelli, 743 Howard St., San Francisco	No published report
Salyer Con.						See Swanson
Sam Hampton	P	16, 17	35 N.	8 W.	C. E. Wright	XIV, p. 918
San Miguel	Q					XVII, p. 542. See Patillo
Schlomberger	P	13	38 N.	9 W.	Frank Schlomberger, Coffee	XXII, p. 48
Schlomer & Meckel	P	28, 29	34 N.	11 W.	See North Fork Placers	XIV, p. 913
Schules	Cr		3 N.	6 E.		U.S.G.S. Bull. 725, pp. 2-4 (map)
Selvester & Wilson	Mn	34	29 N.	11 W.		Bull. 76, pp. 90-91; XXII, p. 63
Senger	P	12, 13	33 N.	10 W.	J. Senger	XIV, p. 913
Shasta Hydraulic Gold Co.	P	5, 7, 8, 9	36 N.	7 W.	c/o Wm. D. McCantey,[5] Rm. 2907, 120 Broadway, New York City	See text this report
Shasta Lily	Hg	14	38 N.	6 W.	George L. Costa, Castella	See text this report
Sheridan	P	18, 19	33 N.	10 W.	Estate of J. S. Sheridan,[5] c/o Wm. J. Dryden, 760 Haight St., Alameda	X, p. 703; XII, p. 313; XIII, p. 462; XIV, p. 913. See text this report
Sherwood	Q	32	8 N.	8 E.	James W. & John H. Bartlett, Denny	X, p. 715; XIII, p. 462; XVII, p. 542
Shoofly	Q	11	33 N.	8 W.	John W. Mercer and others[5]	See Brown Bear
Siegfield	P	25	32 N.	9 W.	E. L. Rogers, et al., Douglas City	No published report
Silver Grey	Q	33	35 N.	10 W.	Geo. Bergin and others, Weaverville	XII, p. 313; XIII, p. 462; XIV, p. 897. See text this report
Slate Creek	P	2, 3	34 N.	9 W.	F. Cadematori	XIV, p. 913
Smith	Q	19, 30, 31	36 N.	9 W.	Paulson & Blake	XI, p. 483; XIII, p. 462; XIV, p. 898
Smith	P	30	35 N.	10 W.	Peter D. Smith, Dedrick	No published report
Smith Creek & Gibson	P	14	32 N.	10 W.	R. K. Gibson,[5] Douglas City	No published report
Smith Cromwell	Q				S. H. Parkhurst	XVII, p. 542
Snow Gulch	P	21, 28	37 N.	7 W.	R. G. Abrams and others, Trinity Center	XIV, p. 918

South Fork	P	26	6 N.	5 E.		XXII, p. 48. See Swanson also
		12	5 N.	5 E.		
Sowden	P	2	33 N.	10 W.		XIII, p. 463; XIV, p. 913
Spider	Mn	17	28 N.	11 W.	John D. Rourke, Weaverville	See text this report
Star of the East	Q	13	33 N.	8 W.	M. F. Bacon and others,[5] 60 S. Rafael Ave., Pasadena	XIV, p. 898
Starvation	Q	11	33 N.	8 W.	F. L. Lewis, Lewiston	See text this report
Steiner's Flat	P	35, 36	33 N.	10 W.	W. D. & G. C. Lorenz, Weaverville	XIV, p. 914; XXIX, p. 70
Stevens Gulch	P		38 N.	9 W.	George Zinn, Coffee	XVII, p. 543
Stick to It	P	8	37 N.	7 W.	Ada G. McDevitt, Carrville	No published report
Stiller	P	4, 10, 22	35 N.	8 W.	J. A. Stiller, Minersville or Redding	No published report
St. Marys & Live Oak	P	24	37 N.	8 W.	J. L. Morrison, Estate of John Larson, Trinity Center	No published report
Strode (Oro Grande)	Q	8, 9	37 N.	7 W.	Strode Mines Co., 626 4th Ave., Milwaukee, Wisconsin	XII, p. 313; XIII, pp. 458-59; XIV, p. 896; XVIII, pp. 207, 257, 600; XX, p. 182; XXVII, p. 54. U.S.G.S. Bull. 530-D, p. 35
Stuart Fork	MP	9, 15	35 N.	8 W.		Bull. 38, p. 342; XXII, p. 63
Sturdivant	P	7, 8, 9	33 N.	10 W.	Richard Gribble,[5] Junction City	XIV, p. 914
Summit	Cr	23, 24	38 N.	6 W.	Bud Wagner, Trinity Center	See text this report
Sunny Slope	Q		34 N.	8 W.	Sunny Slope Mines Co., French Gulch	XVII, p. 542
Sunny Slope	Cr	10	29 N.	11 W.	E. A. Collins, Ono	See text this report
Sunshine	Q	33	38 N.	8 W.		XXII, p. 25
Supplanter	Q	23	7 N.	7 E.(?)	J. & G. Foutes	XIV, p. 898
Swanson	P	20	6 N.	6 E.	Nels Swanson, Burnt Ranch	No published report
Swanson Min. Corp. (Hammer, South Fork, Salyer)	P	14, 15 22, 23 26, 27	6 N.	5 E.	A. J. Swanson, President,[5] Salyer	XIII, p. 463; XIV, p. 913; XXII, pp. 35-36; Bull. 85, pp. 85-88. See text this report
T. & O.	P	12	33 N.	10 W.	P. J. McCarthy & Leo Huebner, Susanville	No published report
Tanner	P	28	34 N.	8 W.	Mabel A. Tanner, 529 W. Doran St., Glendale	No published report
Teal & Perigot	P, Pt	18	6 N.	6 E.	Berthe Perigot,[5] Blue Lake	XIV, p. 905; Bull. 85, p. 89; XXII, pp. 49, 65
Ten Cent	P	6	33 N.	9 W.	R. A. Greenwell,[5] Weaverville	XIV, p. 914
		31	34 N.	9 W.		
Tenner	P	30	8 N.	8 E.	W. L. & R. W. Tenner	XIV, p. 914
Texas Bar	P	6	32 N.	9 W.	G. Vitzhum	XIV, p. 914
Thorne						See Star of the East
Timmerman & McKenzie	P	2, 11	33 N.	10 W.	John I. Adams, Weaverville	No published report
Tinsley & Treloar	P	5	33 N.	12 W.	G. W. Tinsley & E. W. Treloar, Big Bar	XXII, p. 49
Tolly Hill	P	34	35 N.	9 W.	J. H. Cummings	XIV, p. 914
Tom Bell	P	5, 6	33 N.	9 W.	Emma C. Young and others,[5] c/o Van B. Young, Weaverville	XVII, p. 543
Tom Morton Cons.	Q	20, 28, 32	37 N.	6 W.	J. J. Daugherty, 151 Clark Bldg., Canton, Ohio	No published report
Top Notch	P, Pt	12, 13	6 N.	6 E.	F. Renney, Salyer	XIV, p. 915; Bull. 85, p. 89
Toughnut	Q	6	37 N.	12 W.	Tough Nut Co., Denny	X, p. 715; XIII, p. 464; XIV, p. 898
Triangle	Q	11	33 N.	8 W.	J. Hollingsworth	XIV, p. 898
Tri-M	Q	25	32 N.	9 W.	F. L. Morrison and others, Douglas City	See text this report
Trinity	Cr	35	37 N.	6 W.	C. L. Proebstel, Redding	See text this report
Trinity	Hg	21, 22	38 N.	6 W.	Trinity Quicksilver Mining Co., 58 Sutter St., San Francisco	See Altoona also XXII, p. 67; Bull. 78, p. 202
Trinity Cons.	P					See McMurry & Hupp
Trinity Dev. Co.	P	7, 8	37 N.	7 W.	Trinity Development Co., Inc., Holbrook Bldg., 58 Sutter St., San Francisco	No published report

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Footnotes are at end of table.

TABLE OF MINES AND PROSPECTS, TRINITY COUNTY, WITH REFERENCES TO REPORTS OF STATE MINERALOGIST—Continued

Name	Kind of mine[1]	Section	Township	Range[4]	Remarks[2] (Location or ownership)	References to Reports of State Mineralogist[3]
Trinity Dredge	P	5, 6, 7, etc.	33 N.	8 W.	Trinity Dredging Co.,[5] c/o Miss Mary Smith, Lewiston	XIV, p. 919; XVIII, pp. 601, 734-35; XXIX, pp. 70-71; XXXIV, pp. 122-23; Bull. 36, p. 104; Bull. 92, p. 95 Pre. Rep. no. 8, p. 18. U.S.G.S. Bull. 540, p. 20. See text this report
Trinity Farm & Cattle Co.	P	------	36 N.	7 W.	Trinity Farm & Cattle Co., c/o Wm. Foster, Trinity Center	XXIX, p. 71
Trinity Gold	Q	6	31 N.	9 W.	S. G. Lovejoy, Douglas City	XXIX, pp. 52-53
Trinity Mohawk	Q	26, 27	34 N.	8 W.	------	XVIII, p. 498; XXII, p. 26; XXIX, p. 53; X, p. 709
Trinity River Mining Co.	P	5, 8	33 N.	8 W.	Trinity River Mining Co.,[5] c/o S. C. Haight, 2337½ Haste St., Berkeley	X, p. 709; XII, p. 314; XIII, p. 465; XIV, pp. 915-16; XXIX, p. 72. U.S.G.S. Bull. 540, p. 20
Trinity Bonanza King	Q	14	37 N.	7 W.	United Trinity Mines, John R. Ives, Trustee, 805 Mills Bldg., San Francisco	XXII, pp. 25-26. See text this report. See United Trinity also
True Blue	Q	20	37 N.	7 W.	M. H. MacIlwaine,[5] Carrville	XIV, p. 900; U.S.G.S. Bull. 530-D, p. 26
True Fissure	Q	15	35 N.	10 W.	Bank of Tehama	XIV, p. 900
Tuly Creek Chrome	Cr	34(?)	31 N.	12 W.	Rollin Maringer, Redding	See text this report
Twin Chrome Hill	Cr	14(?)	38 N.	6 W.	Emile Chestang, Mt. Shasta	See text this report
Two Sisters & Wonder	P	25	35 N.	8 W.	Lillian N. Hasman,[5] c/o C. M. Derby, 685 6th St., San Francisco	No published report
Tyson	P	30	35 N.	10 W.	C. H. Edwards, Weaverville	No published report
Uncle Sam	Q	5 32	8 N. 9 N.	8 E. 8 E.	J. Cullich	X, p. 715; XIII, p. 465; XIV, p. 900
Union Gulch	P	9	33 N.	9 W.	Eugene Scharr and others,[5] Star Route, Corning	No published report
Union Hill	P	6	32 N.	9 W.	Trinity Consolidated Hydraulic Mining Co.	XII, p. 314; XIII, p. 465; XIV, p. 915; XVIII, pp. 97, 207; XIX, p. 58; Bull. 92, p. 94; XXII, p. 49. U.S.G.S. Bull. 470, p. 25
United Trinity (Trinity Bonanza King)	Q	14	37 N.	7 W.	c/o A. B. Kreft,[5] 805 Mills Building, San Francisco	XIII, p. 440; XIV, p. 876; XVII, p. 539; XXII, pp. 25, 26; XXVII, p. 29. U.S.G.S. Bull. 530-D, p. 36. See text this report
Up Grade	P	7	6 N.	7 E.	Louis A. Maire, Denny	See text this report
Upham	P	29, 30	32 N.	8 W.	F. L. Upham,[5] Douglas City	XXIX, p. 72. See text this report
Upper Dutton Creek	P	26	33 N.	10 W.	The Lorenz Co., c/o Mrs. A. Meininger, Redding	No published report
Upper Eltapom	Cr	------	4 N.	6 E.	------	U.S.G.S. Bull. 725, pp. 2-4 (map)
Valdor	P, Pt	1, 2, etc.	33 N.	11 W.	Valdor Dredging Co., c/o G. A. Hutton, 582 Market St., San Francisco	XIV, p. 916; XXII, p. 64; Bull. 85, p. 84
Van Matre	P	22, 27	35 N.	8 W.	J. C. Van Matre and others, Minersville	XVIII, p. 496; XIX, p. 146; XX, p. 182
Van Ness	------	------	------	------	------	See Five Pines
Various	Cr	------	------	------	------	Bull. 76, p. 224
Venecia	Q	3	33 N.	8 W.	Paulsen Bros., Inc., Lewiston	XIV, p. 900; XVIII, pp. 207, 497; XXIX, p. 56. See text this report
Vermont	Q	13	33 N.	8 W.	J. H. Blagrave, French Gulch; B. A. Graham, Ydalpom	See text this report
Viking Dredge	P	12	32 N.	10 W.	Viking Dredging Co., J. C. Hamilton, Mgr., Box 498, Chico	XXXIV p. 123. See text this report

Wagner	Q	34	38 N.	8 W.	E. A. Wagner and others,[5] Carrville	U.S.G.S. Bull. 530-D, p. 28. See Modoc Gold Mines also
Wallace	P	13, 14	32 N.	9 W.	W. O., L. S. & David Wallace, Douglas City	No published report
Ward	P	10, 11	33 N.	10 W.	Robert Ward,[5] c/o Dr. Lyman Stookey, Weaverville	XIII, p. 466; X, p. 696; XI, p. 484
Watson Bar	P	23	5 N.	7 E.		XIII, p. 466
Watson	Q	25	28 N.	11 W.	J. R. Watson, Knob	No published report
Weaver Creek	P	19, 30	33 N.	9 W.	W. A. Brady, Weaverville	No published report
Weaver Dredging Company	P	1	32 N.	10 W.	c/o Oscar R. Batham, Weaverville	XXXIV, p. 123. See text this report
Wheaton & Stuart	P	8, 9	33 N.	10 W.	Richard Gribble, Junction City	No published report
White Cloud	Q	3 or 5	34 N.	8 W.	J. W. Phillips, Lewiston	XIV, p. 900
Whitmore Gold	P	19	33 N.	10 W.	Estate of Jane Gribble,[5] c/o Richard Gribble, Junction City	No published report
Wild Cat	P	34	35 N.	9 W.	J. H. Cummings,[5] Weaverville	No published report
Wild Cat	Cr	6(?)	36 N.	6 W.	A. D. Grafton, Lamoine	See text this report
Wilker	P	5	39 N.	7 E.	J. E. Crawford	XIV, p. 918
Williams, F. S.	Cr	34	30 N.	11 W.		
Woodbury	P	7	33 N.	9 W.	Willis Woodbury, Weaverville	See text this report
Woodbury	P	35	31 N.	11 W.		XIV, p. 916
Woodbury (Garden Gulch)	P	36	34 N.	10 W.	Estate Mrs. M. L. Woodbury,[5] 1480 9th Ave., San Francisco	No published report
Yellow Aster	Q	21, 29	35 N.	11 W.	East Fork Development & Mining Company	XIV, pp. 900-01
Yellow Rose of Texas	Q	20	37 N.	9 W.	D. V. Saeltzer[5] and others, Redding	XXII, pp. 26-27; XXVII, p. 55. U.S.G.S. Bull. 530-D, pp. 34-35
Yellowstone	Q	29, 32	35 N.	11 W.	Chiksan Oil Co.,[5] Fullerton	X, p. 711, XI, p. 482; XII, p. 314; XIII, p. 466; XXII, p. 27. See Enterprise in text this report
Yellow Surprise	Q	10	33 N.	11 W.	Clarence Kunkler, Jack Smith, Junction City	See text this report

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[1] Asb, asbestos; Cr, chromite; Cu, copper; GR, granite; Hg, quicksilver; ls, limestone; Mn, manganese; Mo, molybdenum; MP, mineral paint; MS, mineral spring; P, gold placer; Pt, platinum; Q, gold quartz; SO, soapstone; VO, volcanic ash.

[2] Addresses are in California unless otherwise noted.

[3] Some references to publications of the United States Geological Survey (U.S.G.S.) are included.

[4] Ranges west (W.) are referred to Mount Diablo Meridian; ranges east (E.) to Humboldt Meridian.

[5] Names and addresses marked thus have been checked against the records of the Assessor of Trinity County for 1939. Names and addresses not so marked are those of the last person known to a representative of this division to have claimed ownership.

GEOLOGIC BRANCH

CURRENT NOTES

By OLAF P. JENKINS, Chief Geologist

In this issue of the JOURNAL are two outstanding and timely articles on strategic minerals.

The first, contributed by Charles White Merrill, supplements the author's earlier paper published in the July, 1938, JOURNAL, and records the progress on strategic mineral work by the Government.

Mr. Merrill is especially qualified to write on "Strategic Minerals Procurement," since he has made a special study of the subject of strategic minerals. Mr. Merrill is both Supervising Engineer, United States Bureau of Mines, and Captain, Specialist Reserve, United States Army.

The second article, contributed by John Eliot Allen, is a comprehensive report on the geology of chromite deposits of California; chromite being one of the most important of our strategic minerals.

Having investigated chromite deposits throughout both California and Oregon for a period of some years, Mr. Allen has been able to present in his "Geological Investigation of the Chromite Deposits of California" an outstanding, authoritative report, which should be exceedingly helpful to prospectors and exploration companies, as well as to the research geologists and engineers of the U. S. Geological Survey and U. S. Bureau of Mines, who are now just starting intensive field surveys of chromite deposits in this State.

The next several issues of the JOURNAL will contain reports on other strategic minerals. These reports will be followed by economic mineral maps of the State that will show in detail the distribution of these deposits of minerals important in National defense.

STRATEGIC MINERALS PROCUREMENT*

By Charles White Merrill **

Since 1938, when ''Strategic Minerals in California'' was written,[1] international conditions have drawn popular attention to the importance of certain minerals in the defense of the United States. During the intervening two years the lists of strategic and critical commodities have been revised, several laws have been enacted bearing on these commodities, and almost one-third of a billon dollars has been appropriated by Congress to finance programs to make the United States less dependent on supplies that might be cut off by a foreign enemy. The following paragraphs will outline the history of strategic mineral procurement planning and cover in more detail the Federal Government's plans and actions in this field during recent months.

A discussion of the strategic minerals problem should begin with the defining of some terms that had not reached common use until the present emergency. The Army and Navy Munitions Board approved January 30, 1940, the following definitions and lists of strategic and critical materials:

> *Strategic materials* are those essential to national defense, for the supply of which in war dependence must be placed in whole, or in substantial part, on sources outside the continental limits of the United States; and for which strict conservation and distribution control measures will be necessary.
>
> *Critical materials* are those essential to national defense, the procurement problems of which in war would be less difficult than those of strategic materials either because they have a lesser degree of essentiality or are obtainable in more adequate quantities from domestic sources; and for which some degree of conservation and distribution control will be necessary.

Strategic Materials

Antimony
Chromium
Coconut Shell Char
Manganese, Ferrograde
Manila Fiber
Mercury
Mica
Nickel
Quartz Crystal
Quinine
Rubber
Silk
Tin
Tungsten

Critical Materials

Aluminum
Asbestos
Cork
Graphite
Hides
Iodine
Kapok
Opium
Optical Glass
Phenol
Platinum
Tanning Materials
Toluol
Vanadium
Wool

In addition to the strategic and critical materials there is a much longer list of commodities necessary to the war industries but which are supplied adequately from domestic resources; these are termed

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* Published by permission of the Director, Bureau of Mines, U. S. Dept. of the Interior.

** Supervising Engineer, San Francisco office, Mineral Production and Economics Division, Bureau of Mines, and Captain, Specialist Reserve, U. S. Army.

[1] Merrill, Charles White, Strategic Minerals in California; Calif. Jour. Mines and Geol., State Mineralogist's Report 34, vol. 34, No. 3, July, 1938, pp. 283-291.

"Essential Materials." The Army and Navy Munitions Board maintains surveillance over some of these essential materials that might become critical or strategic; this list is not made public.

During the last 20 years Government agencies and public-spirited citizens have been studying the strategic minerals problem in connection with national defense. Profiting from the experience of the World War, Congress, as a part of the Defense Act of 1920, charged the Assistant Secretary of War with the procurement of all War Department supplies and the mobilization of industry in the event of war. The Assistant Secretary's office has directed the formation of many plans in this connection. Shortly after the first World War the War Department requested a joint committee of the American Institute of Mining and Metallurgical Engineers and the Mining and Metallurgical Society of America to study the question of strategic minerals and submit recommendations for Governmental action; after exhaustive investigation the committee submitted a report in January, 1924, and its essential recommendations were:

> 1—The immediate purchase of stockpiles of strategic minerals to be held in reserve against war emergencies.
>
> 2—The discouragement of artificial stimuli, such as tariffs, in times of peace, which, if effective, would tend to deplete already limited domestic resources that should be preserved for emergency use to supplement the stockpiles.

In 1927 the Secretary of War in his annual report recommended legislation designed to effect the accumulation of 600,000 tons of manganese ore as a war-reserve stockpile. In 1931 a group of eminent mining engineers was requested by the War Department to review and bring up to date the report on manganese prepared in 1924 by the two professional societies. In addition to confirming the conclusions found in the earlier report, this committee recommended

> concrete research by the proper Government agencies, to the end that fully demonstrated methods (for exploiting submarginal domestic deposits) supported by detailed designs and plans may actually be in hand on the eve of a war emergency.

Virtually this same program was recommended by the President's Planning Committee for Mineral Policy in the report of the National Resources Board, dated December 1, 1934. Some concrete progress was made when the Navy Department Appropriation Bills for 1938 and 1939 allocated small sums for the purchase of stockpiles of strategic materials for Navy use only. The allocations, however, have been insufficient to cover the cost of accumulating stockpiles adequate to meet even the Navy's requirements.

In April, 1938, the Director of the Bureau of Mines urged the mining industry to support the recommendations of various impartial committees that have studied the subject, namely:

> 1—The immediate purchase of adequate stockpiles of strategic minerals of standard quality as the most effective means of meeting the present problems of national defense.
>
> 2—The annual appropriation of $500,000 by the Government to be used by the Bureau of Mines and Geological Survey for the purpose of comprehensive studies of ways and means of adapting our domestic reserves of strategic minerals to a permanent solution of our deficient mineral problem.

These years of study had shown that there are only four ways to supply the need for strategic materials; each method has its place in the national defense procurement program. The procurement methods are:

1—Stockpiling when supplies are abundantly available.
2—Developing currently noncommercial domestic deposits.
3—Developing substitutes.
4—Insuring the flow of foreign material under all conditions.

Besides these four methods, consideration is given also to curtailment of consumption for nonessential uses and the maximum reclamation of secondary material during emergencies.

The defense program of the last two years has made provision to take advantage of all these procurement methods. On June 7, 1939, the President signed Public 117,[2] the "Strategic Materials Act," which provided for stockpiling and domestic development. The first appropriation, $10,000,000, under the act was made in August, 1939. Almost immediately the Procurement Division, Branch of Supply, Treasury Department, started issuing invitations to bid on various lots of strategic minerals. The following typical invitation to bid was entitled "Specifications and Proposals for Supplies—Chromium Ore," issued May 10, 1940, by the Treasury Department, Procurement Division, Washington, D. C.:

Conditions

1. *Domestic origin.* Unless otherwise specified by the bidder, it is understood and agreed that only such unmanufactured articles, materials, and supplies as have been mined or produced in the United States, and only such manufactured articles, materials, and supplies as have been manufactured in the United States substantially all from articles, materials, or supplies mined, produced, or manufactured as the case may be, in the United States shall be delivered pursuant to a contract awarded as a result of this bid, except articles, materials, and supplies of the kind required or articles, materials, or supplies from which they are manufactured which are not mined, produced, or manufactured, as the case may be, in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality.

2. *Federal tax.* Supplies and material required for the exclusive use of the United States may be exempted from payment of the manufacturers excise tax imposed by title IV of the Revenue Act of 1932, as amended. A tax-exemption certificate will be furnished to exempt the article from the tax, when tax exemption is claimed by the bidder in the execution of the following stipulations:

> The amount of Federal tax paid or payable on articles subject to tax under title IV of the Revenue Act of 1932, as amended, is (included in—excluded from) the prices bid herein, and the bidder (has—has not) claimed and/or (will—will not) claim exemption from, credit for, or refund of such taxes with respect to sales of said articles, as provided by law.

3. *Prices inclusive of tax.* Prices bid herein include any Federal tax heretofore imposed by the Congress which is applicable to the material on this bid. If any sales tax, processing tax, adjustment charge, or other taxes or charges are imposed or changed by the Congress after the date set for the opening of this bid, and made applicable directly upon the production, manufacture or sale of the supplies covered by this bid, and are paid by the contractor on the articles or supplies herein contracted for, then the prices named in this bid will be increased or decreased accordingly, and any amount due the contractor as a result of such change will be charged to the Government and entered on vouchers (or invoices) as separate items.

4. *Sales tax (State, Local, etc.).* Revenue taxes imposed by States, municipalities, or subdivisions thereof on the sale of articles, are not applicable to sales to the Federal Government. A tax exemption certificate will be furnished, if required, when the following information is furnished by the bidder:

(a) Name of the taxing agency (State, local, etc.)___________________
(b) Amount of tax, $____

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[2] The Act in full was published in Calif. Jour. Mines and Geol., State Mineralogist's Report 35, vol. 35, No. 3, July 1939, pp. 331-333.

5. *Walsh-Healey (Public Contracts) Act.* Representations and stipulations pursuant to Public Act No. 846, Seventy-fourth Congress:

(a) The contractor is the manufacturer of or a regular dealer in the materials, supplies, articles, or equipment to be manufactured or used in the performance of the contract.

(b) All persons employed by the contractor in the manufacture or furnishing of the materials, supplies, articles, or equipment used in the performance of the contract will be paid, without subsequent deduction or rebate on any account, not less than the minimum wages as determined by the Secretary of Labor to be the prevailing minimum wages for persons employed on similar work or in the particular or similar industries or groups of industries currently operating in the locality in which the materials, supplies, articles, or equipment are to be manufactured or furnished under the contract: *Provided, however,* That this stipulation with respect to minimum wages shall apply only to purchases or contracts relating to such industries as have been the subject matter of a determination by the Secretary of Labor.

(c) No person employed by the contractor in the manufacture or furnishing of the materials, supplies, articles, or equipment used in the performance of the contract shall be permitted to work in excess of 8 hours in any 1 day or in excess of 40 hours in any 1 week, unless such person is paid such applicable overtime rate as has been set by the Secretary of Labor.

(d) No male person under 16 years of age and no female person under 18 years of age and no convict labor will be employed by the contractor in the manufacture or production or furnishing of any of the materials, supplies, articles, or equipment included in the contract.

(e) No part of the contract will be performed nor will any of the materials, supplies, articles, or equipment to be manufactured or furnished under said contract be manufactured or fabricated in any plants, factories, buildings, or surroundings or under working conditions which are insanitary or hazardous or dangerous to the health and safety of employees engaged in the performance of the contract. Compliance with the safety, sanitary, and factory inspection laws of the State in which the work or part thereof is to be performed shall be prima facie evidence of compliance with this subsection.

(f) Any breach or violation of any of the foregoing representations and stipulations shall render the party responsible therefor liable to the United States of America for liquidated damages, in addition to damages for any other breach of the contract, in the sum of $10 per day for each male person under 16 years of age or each female person under 18 years of age, or each convict laborer knowingly employed in the performance of the contract, and a sum equal to the amount of any deductions, rebates, refunds, or underpayment of wages due to any employee engaged in the performance of the contract; and, in addition, the agency of the United States entering into the contract shall have the right to cancel same and to make open-market purchases or enter into other contracts for the completion of the original contract, charging any additional cost to the original contractor. Any sums of money due to the United States of America by reason of any violation of any of the representations and stipulations of the contract as set forth herein may be withheld from any amounts due on the contract or may be recovered in a suit brought in the name of the United States of America by the Attorney General thereof. All sums withheld or recovered as deductions, rebates, refunds, or underpayments of wages shall be held in a special deposit account and shall be paid, on order of the Secretary of Labor, directly to the employees who have been paid less than minimum rates of pay as set forth in such contracts and on whose account such sums were withheld or recovered: *Provided,* That no claims by employees for such payments shall be entertained unless made within 1 year from the date of actual notice to the contractor of the withholding or recovery of such sums by the United States of America.

(g) The contractor shall post a copy of the stipulations in a prominent and readily accessible place at the site of the contract work and shall keep such employment records as are required in the regulations under the act available for inspection by authorized representatives of the Secretary of Labor.

(h) The foregoing stipulations shall be deemed inoperative if this contract is for a definite amount not in excess of $10,000.

6. *Bond Requirements.* (a) Bids in excess of $1,000 shall be accompanied by a bid guaranty, of not less than two percent (2%) of the amount of the bid, which may be bid bond on U. S. Standard Form No. 24, or money order, certified check, or cashier's check, made payable to the Treasurer of the United States. Money orders and checks of unsuccessful bidders will be returned when award is made; money order or check of the successful bidder will be returned when performance bond is approved.

(b) On awards in excess of $1,000, a performance bond (U. S. Standard Form No. 25) in the amount of twenty percent (20%) of the amount of the award must be furnished to guarantee the faithful performance of the contract.

(c) In lieu of sureties on bid or performance bond referred to above, there may be deposited (in accordance with Treasury Department Circular No. 154, dated February 6, 1935) bonds or notes of the United States. "Bonds or notes of the United States" means any public-debt obligation of the United States and any bonds, notes, or other obligations which are unconditionally guaranteed as to both interest and principal by the United States.

(d) The furnishing of a bond may be waived if so directed by the Secretary of War and the Secretary of the Navy, if they find the production of the material covered by the proposal to be economically feasible. (Section 5 of Public Act No. 117, 76th Congress.)

7. *Oral Modification Inadmissible.* No oral statement of any person shall be allowed in any manner or degree to modify or otherwise affect the terms of these conditions, the specifications, or the contracts.

8. *Transmittal of Proposal.* Proposals, after being prepared and signed in accordance with conditions herein given, shall be placed in the special envelope provided, which shall be properly sealed, marked on the upper left-hand corner with the name and address of the bidder, and sent by mail, postage prepaid, or delivered personally, to the Treasury Department, Procurement Division, Seventh and D Streets SW., Washington, D. C. As openings commence at 10 a.m., proposals, to receive consideration, must reach the Division not later than that hour on the date of opening. An addressed envelope, which should be used for mailing, is enclosed.

9. *Bid Rejections; Default.* The right is reserved to the contracting officer to reject any and all bids, to waive technical defects or any informalities, and to accept or reject any part of any bid, if, in his judgment, the interests of the Government shall require it; also the right to declare any contractor in default if, in his opinion, there has been at any time a failure to perform faithfully any of the contract stipulations, or in case of a wilful attempt to impose upon the Government articles inferior to those required by the contract; and any action taken by the contracting officer, in pursuance of this latter stipulation, shall not affect or impair any right or claim of the United States to damages for breach of any of the covenants of the contract by the contractor. It is understood and agreed that when a contractor has been declared in default, the Government of the United States may purchase the articles covered by the contract of the defaulting contractor, and any excess in cost over the original contract price shall be charged to said defaulting contractor and/or his sureties.

10. *Increase or Decrease in Quantity.* Unless the bidder takes exception, the Government reserves the right to increase or decrease the quantity specified in the proposal by not to exceed 25 percent at any time before award of contract: *Provided,* That with the consent of the contractor, such increase or decrease may be made in the total quantity under any contract at any time before complete shipment.

11. *Method of Award.* The right is reserved to make one award on each subitem or item, or a group of subitems or items, as may be in the best interests of the Government. Discounts offered for payment in less than 20 days will not be considered in the evaluation of bids.

12. *Delivery Date.* Unless otherwise specified herein, the date of delivery will be that of acceptance of the material by the Government's inspector. Delivery must be completed within 6 months from the date of the purchase order.

13. *Inspection and Test.* Supplies shall be subject to inspection in accordance with the provisions of article 4 of the standard Government form of contract (U. S. Standard Form No. 32, revised), which reads as follows:

> "Article 4. *Inspection.*—(a) All material and workmanship shall be subject to inspection and test at all times and places and, when practicable, during manufacture. In case any articles are found to be defective in material or workmanship, or otherwise not in conformity with the specification requirements, the Government shall have the right to reject such articles, or require their correction. Rejected articles, and/or articles requiring correction, shall be removed by and at the expense of the contractor promptly after notice so to do.
>
> "(b) If inspection and test, whether preliminary or final, is made on the premises of the contractor or subcontractor, the contractor shall furnish, without additional charge, all reasonable facilities and assistance for the safe and convenient inspections and tests required by the inspectors in the performance of their duty. All inspections and tests by the Government shall be performed in such a manner as not to unduly delay the work. Special and performance tests shall be as described in the specifications. The Government reserves the right to charge to the contractor any additional cost of inspection and test when articles are not ready at the time inspection is requested by the contractor.
>
> "(c) Final inspection and acceptance of materials and finished articles will be made after delivery, unless otherwise stated. If final inspection is made at a point other than the premises of the contractor or a subcontractor, it shall be at the expense of the Government except for the value of samples used in case of rejection. Final inspection shall be conclusive except as regards latent defects, fraud or such gross mistakes as amount to fraud. Final inspection and acceptance or rejection of the materials or supplies shall be made as promptly as practicable, but failure to inspect and accept or reject materials or supplies shall not impose liability on the Government for such materials or supplies as are not in accordance with the specifications. In the event public necessity requires the use of materials or supplies not conforming to the specifications, payment therefor shall be made at a proper reduction in price."

14. *Use of Material.* Section 4 of Public Act No. 117, 76th Congress, is quoted below:

> "Materials acquired under this Act except for rotation to prevent deterioration shall be used only upon the order of the President in time of war, or when he shall find that a national emergency exists with respect to national defense as a consequence of the threat of war."

15. *Member of or Delegate to Congress.* Section 3741, Revised Statutes, as amended (41 U. S. C. 22) provides, in substance, as follows:

> No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract that may be made as a result of this advertisement or to any benefit that may arise therefrom, but this provision shall not be construed to extend to such a contract if made with a corporation for its benefit.

16. *Ships of United States Registry Only* shall be used (if available) in the transportation of the material transported to the United States in fulfillment of a contract resulting from this advertisement.

17. *Billing Instructions.* Invoices in payment shall bear the following certificates signed by the duly authorized representative of the contractor billing the materials:

> "I certify that the above bill is correct and just; that payment therefor has not been received; and that, except as otherwise noted, all of the articles, materials, and supplies covered by this invoice, if unmanufactured articles, materials, and supplies have been mined or produced in the United States, and if manufactured articles, materials, and supplies they have been manufactured in the United States substantially all from articles, materials, or supplies mined, produced, or manufactured, as the case may be. in the United States.
>
> "I certify that the stipulations required by law and/or under contract, etc., with respect to wages, rights, and hours of work of employees have been complied with."

In case the bidder qualified the domestic-material clause, the exception must be indicated on the invoice as an addition to or modification of the prescribed certificate.

The prescribed certificate shall be printed, typed, or stamped on the voucher or invoice. In cases where it is physically impossible to execute additional certificates on the face of the invoice, these certificates will be placed on the reverse of the invoice. Additional (separate) sheets for certifications only will not be accepted.

The certificates may be executed separately or combined in one certificate at the option of the contractor.

SPECIFICATIONS AND PROPOSALS FOR SUPPLIES

No. S-26

Bids are invited for supplying the United States Government with chromium ore, in the quantities specified, in strict accordance with Procurement Division Specification S.M.-6, under the conditions appearing on pages 3 to 5 of these specifications and proposals and the special conditions and terms hereinafter set forth.

SPECIFICATION S.M.-6

1. GRADE. This specification covers one grade of chromium ore.

2. MATERIAL AND WORKMANSHIP. The chromium ore shall be as required by the following paragraphs.

3. GENERAL REQUIREMENTS. See Detail Requirements.

4. DETAIL REQUIREMENTS. (a) Chromium ore shall be furnished in lumps. All lumps shall pass a 6-inch screen. Not more than 10 percent shall pass a ½-inch-mesh sieve.

(b) Each shipment of ore shall be suitable for the manufacture of ferrochromium (all grades except "A") in strict accordance with Federal Specification QQ-F-151, by the usual commercial methods of manufacture, without blending with other ores.

(c) The chromium ore shall be of the following composition:

Element	Percentage
Chromium oxide (Cr_2O_3) (minimum)	48.0
Iron (metallic) (maximum)	⅓ of the actual percentage of chromium (metallic)
Sulfur (maximum)	.50
Phosphorus (maximum)	.20

(d) All chromium ore delivered in a single cargo or lot shall be of the same average chemical analysis.

(e) All cars prior to loading with ore shall be broom-swept free from sand or any other foreign matter. All leaks shall be calked tight to prevent loss in transportation.

(f) All tare weights of cars shall be actual weight of clean cars. Stencil weights will not be accepted in determining the delivered weight.

SPECIAL CONDITIONS

1. BIDS. (a) Unless specifically authorized, telegraphic bids will not be considered, but modifications by telegraph of bids already submitted will be considered if received prior to the hour set for opening. TELEPHONIC QUOTATIONS WILL NOT BE CONSIDERED.

(b) Bidders may specify the limit of the time (not less than 10 days) during which their proposals may be considered. If no time limit is specified, the proposal will be considered as in force until accepted or rejected by the Government.

(c) Offers containing *force majeure* clause will be given consideration.

2. SOURCE OF MATERIALS. Materials covered by this proposal are to be new importations from foreign sources or materials available from domestic mines. Bidders are specifically advised that no bids will be considered on ores that are now in the United States under bond.

3. AWARD OF CONTRACT. Notification of award of contract will be made by telegraph as soon as practicable after bids are opened.

4. METHODS OF SAMPLING, INSPECTION, AND TESTS. Sampling, weighing, and analysis shall be performed for the Government by independent American chemists experienced in the sampling and analysis of chromium ore in accordance with the latest and most accurate methods. Domestic ore shall be sampled and weighed at destination; foreign ore, at port of discharge.

Chemical analysis shall be made for the Government in accordance with the most accurate methods for determining the following constituents:

Chromium oxide (Cr_2O_3)
Iron (metallic)
Silica (SiO_2)
Alumina (Al_2O_3)
Magnesia (MgO)
Sulfur
Phosphorus

5. PAYMENT. Payment for each shipment will be made on the basis of actual chromic oxide content as shown by chemical analysis and weights received, as determined by recognized independent American chemists.

Almost all of the material purchased was of foreign origin. This was to be expected, however, because the strategic materials list is made up of those very commodities that domestic industry for many years has failed to supply in large quantities. Nevertheless, special consideration has been given to domestic producers, including a 25-percent price preference in bidding as authorized under the ''Buy American Act'' (Title III, Act March 3, 1933—47 Stat. 1520). In accumulating the stockpiles it has been the policy to purchase the highest-grade material because high-grade material can always be diluted with the usually abundant domestic lower-grade material, but low-grade can not so readily be tranformed into high-grade.

The Treasury Department announced that purchases of strategic materials as of June 30, 1940, were:

Tungsten ore, 449 short tons	$500,944
Quartz crystals, 11,800 lbs.	98,875
Optical glass, 11,400 lbs.	75,200
Manila fiber, 14,800 bales	234,935
Chromium ore, 64,500 long tons	1,847,850
Pig tin, 6,124 short tons	5,819,916
Manganese ore, ferro-grade, 86,500 long tons	2,575,368
Quinine sulfate, 700,000 oz.	404,600
	$11,557,688

Under the same act work was started on a number of projects by the Bureau of Mines[3] and the Geological Survey. In addition to the preliminary examination of several hundred prospects and mines, the

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[3] Finch, John W., Strategic Minerals Investigations—Procedure followed by the Bureau of Mines: Bureau of Mines Inf. Circ. 7097, 1939, 5 pp.

Bureau made detailed examinations, including much trenching and diamond drilling at the following properties:

Project 101—Antimony Deposits of Valley County, Idaho.
Project 201—Chromium Deposits of Stillwater County, Montana.
Project 202—Chromium Deposit at Casper Mountain, Wyoming.
Project 203—Chromium Deposits in Grant County, Oregon.
Project 301—Manganese Deposits of the Olympic Peninsula, Washington.
Project 601—Tin Deposits in the Black Hills, South Dakota.
Project 602—Tin Deposits of Catron County, New Mexico.
Project 701—Tungsten Deposits of Pershing County, Nevada.

Detailed examination work by the Survey resulted in printing (in 1940) of several parts of Geological Survey Bulletin 922, as follows:

Part A—Quicksilver Deposits of the Bottle Creek District, Humboldt County, Nevada, by Ralph J. Robert.
Part B—Quicksilver Deposits of the Mount Diablo District, Contra Costa County, California, by Clyde P. Ross.
Part C—Manganese Deposits in the Little Florida Mountains, Luna County, New Mexico, by S. G. Lasky.
Part D—Chromite Deposits of Grant County, Oregon, by T. P. Thayer.
Part E—Quicksilver Deposit of Buckskin Peak, National Mining District, Humboldt County, Nevada, by R. J. Roberts.
Part F—Tungsten Deposits of Boulder County, Colorado, by T. S. Lovering.
Part G—Manganese Deposits at Philipsburg, Granite County, Montana, by E. N. Goddard.
Part H—Tungsten Deposits of the Atolia District, San Bernardino and Kern Counties, California, by Dwight M. Lemmon and John V. N. Dorr, 2d.
Part I—Antimony Deposits of a Part of the Yellow Pine District, Valley County, Idaho, by Donald E. White.
Part K—Antimony Deposits of the Wildrose Canyon Area, Inyo County, California, by Donald E. White.
Part M—Tin Deposits of the Black Range, Catron and Sierra Counties, New Mexico, by Carl Fries, Jr.

The Bureau of Mines also carried on extensive metallurgical work in connection with the utilization of low-grade and refractory materials containing strategic metals. Improved ore dressing or metallurgy may prove the decisive factor in changing heretofore worthless rock into ore yielding strategic metal.

In October, 1940, an additional $275,000 was appropriated by Congress to expand the strategic mineral work of the Bureau of Mines, and $90,000 was added to the Geological Survey to increase the geologic work on strategic minerals during the fiscal year ending June 30, 1941.

When it appeared that the competitive bidding system of acquiring materials, as practiced under the Strategic Materials Act, was not producing stockpiles fast enough, supplemental methods were studied. The result was the passage of Public 664 by Congress, which, among other provisions, authorized the Reconstruction Finance Corporation to finance public corporations for acquiring strategic materials by negotiation. The pertinent parts of Public 664 are as follows:

> To authorize the purchase by the Reconstruction Finance Corporation of stock of Federal Home-Loan banks; to amend the Reconstruction Finance Corporation Act, as amended, and for other purposes.
>
> * * * * * *
>
> Sec. 5. Section 5d of the Reconstruction Finance Corporation Act, as amended (U. S. C., 1934 edition, Supp. V, title 15, Sec. 606b), is hereby amended by adding at the end thereof the following new paragraphs:
>
> In order to aid the Government of the United States in its national-defense program, the Corporation is authorized—
>
> (1) To make loans to, or, when requested by the Federal Loan Administrator with the approval of the President, purchase the capital stock of, any corporation (a) for the purpose of producing, acquiring, and carrying strategic and critical materials as defined by the President, and (b) for plant construction,

> expansion and equipment, and working capital, to be used by the corporation in the manufacture of equipment and supplies necessary to the national defense, on such terms and conditions and with such maturities as the Corporation may determine; and
>
> (2) When requested by the Federal Loan Administrator, with the approval of the President, to create or to organize a corporation or corporations, with power (a) to produce, acquire, and carry strategic and critical materials as defined by the President, (b) to purchase and lease land, to purchase, lease, build, and expand plants, and to purchase and produce equipment, supplies, and machinery, for the manufacture of arms, ammunition, and implements of war, (c) to lease such plants to private corporations to engage in such manufacture, and (d) if the President finds that it is necessary for a Governmental agency to engage in such manufacture, to engage in such manufacture itself. The Corporation may make loans to, or purchase the capital stock of, any such corporation for any purpose within the powers of the corporation as above set forth related to the national-defense program, on such terms and conditions as the Corporation may determine.
>
> Any corporation created or organized by the Corporation under the preceding paragraph is also authorized, with the approval of the President, to make payments against the purchase price to be paid for strategic and critical materials in advance of the delivery of such materials. Whenever practicable, the Corporation may require the payments so made to be used for purchases of raw or manufactured agricultural commodities to be exported from the United States.

Further stimulation of domestic production of strategic minerals by making capital available to private enterprises for development work, was provided in Congressional Act Public 784. This bill liberalized the terms under which the Reconstruction Finance Corporation might lend funds for development of strategic mineral properties. A total of $10,000,000 was appropriated for loans, and a maximum of $20,000 was set as the amount available to any one individual, corporation, or partnership, with the provision that a second $20,000 could be made available if the first expenditure resulted in favorable developments.

Domestic producers and potential producers of strategic minerals were greatly encouraged by the inclusion of the following clause in the new excess profits bill passed in the Senate late in 1940:

> Income derived from the mining reduction, or beneficiation of tungsten, quicksilver, manganese, platinum, antimony, chromite, and tin, or the ores and materials containing such metals, shall not be subject to the excess profits tax provided in this act.

Thus those strategic mineral enterprises that are only profitable under the high prices of the present emergency have a chance of returning the investment before the return of normal conditions will inevitably shut them down.

The National Defense Advisory Commission, organized in May, 1940, under a Defense Act of 1916, places responsibility for raw material supplies with Commissioner E. R. Stettinius, Jr. As the procurement of strategic materials is so important in national defense the Commission has been very active in this field, and the Commission's plans are closely coordinated with those of the Army and Navy Munitions Board, the Assistant Secretary of War's office, and other Government agencies working on the problem.

The California State Division of Mines has not been inactive in the strategic minerals program. In addition to the recently released geologic map of California [4] and a number of other general publications on California geology and mineral resources, the Division has published

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[4] Jenkins, Olaf P., Geologic map of California: Dept. of Nat. Res. California, Div. of Mines, 1938.

''Quicksilver in California''[5] and a map[6] showing locations of quicksilver properties, and has articles on chromite, tungsten, and manganese in manuscript ready for early publication. This work is exceedingly important because the known strategic mineral resources of California exceed those of any other State, as was demonstrated in 1918, when the State was the leading source of quicksilver and chromite and was second in output of manganese ore and tungsten.

Many questions in the minds of those who want to do their part in providing strategic minerals can be answered by listing what the Government does not do. No Government agency purchases mineral properties or pays any premium or bonus to prospectors, owners, or operators of mines; no compensation or gratuity is paid for information leading to the discovery of mineral deposits. No federal agency makes free assays or analyses of ore to save the public the expense of commercial assayers or chemists, and no agency examines mines upon request to save their owners the cost of examination by mining engineers.

Sight must not be lost of the fact that the strategic mineral problem is a defense problem. Those responsible for protecting the Nation by assuring adequate supplies of all materials essential to the war industries have never deviated from the policy of striving for a maximum of defense with the money available. There are many other factors to be considered, such as relief of unemployment and development of new industries, but all these factors must be subordinated to the main problem of defense itself under the emergency defense conditions facing the Nation at present.

The strategic material outlook as a whole is not discouraging. During the years since the last war the number of strategic materials has decreased. At present, public stockpiles have begun to accumulate in a substantial way, and privately owned stockpiles of several of the strategic commodities are adequate for many months. The position of the Navy has not been challenged seriously, thus giving hope that most foreign supplies will continue to be available even in the event of war. Stimulation of domestic output by higher prices seems virtually to have solved the quicksilver problem, at least temporarily, and to have decreased substantially the dependence of domestic consumers of tungsten on foreign mines. Although practically no new strategic mineral resources have been discovered, the development work at marginal and submarginal deposits has been gratifying. The probability remains, however, that a major war effort would reveal serious shortages of some of these commodities, but it does not now seem likely that any shortage will prove disastrous.

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[5] Ransome, Alfred L. and Kellogg, John L., Quicksilver resources of California: Calif. Jour. Mines and Geol., State Mineralogist's Report 35, vol. 35, No. 4, 1939, pp. 353-486.

[6] Jenkins, Olaf P., Outline geologic map of California showing location of quicksilver properties: Dept. of Nat. Res., California, Div. of Mines, 1939.

GEOLOGICAL INVESTIGATION OF THE CHROMITE DEPOSITS OF CALIFORNIA

By John Eliot Allen *

OUTLINE OF REPORT

Page
ABSTRACT ---------- 103
INTRODUCTION ---------- 104
  Scope of report ---------- 104
  Acknowledgements ---------- 104
GEOLOGIC FEATURES OF THE CHROMITE DEPOSITS ---------- 104
  Previous studies ---------- 104
  Characteristics of the orebodies ---------- 106
  Discussion of genetic features ---------- 110
  Summary of conclusions ---------- 114
DESCRIPTIONS OF THE OREBODIES ---------- 116
  Chrome districts in California ---------- 116
  Chromite deposits in the Klamath Mountains ---------- 116
    Previous work ---------- 116
    Description of Klamath Mountains province ---------- 116
    Del Norte County ---------- 117
      High Plateau ---------- 117
      Gasquet group ---------- 118
        Fairview ---------- 118
        Margy ---------- 118
        Niggerhead ---------- 118
        Angela ---------- 119
        Blackjack ---------- 119
      Soldier's Wells group ---------- 119
        Deposit A ---------- 119
        Deposit B ---------- 120
        Deposit C ---------- 120
      Zinc Saddle ---------- 120
      Hawkins ---------- 120
      Camp 7 group ---------- 121
        Prospect ---------- 121
        Cooncan ---------- 121
        Camp 7 ---------- 122
      Camp 8 ---------- 122
    Siskiyou County ---------- 123
      Youngs Valley group ---------- 123
        Doe Creek ---------- 123
        Mammoth ---------- 123
        White Feather ---------- 123
      North of Seiad ---------- 124
        Blue Eagle claim ---------- 124
        Black Eagle claim ---------- 124
      Seiad Valley ---------- 125
      Hamburg ---------- 125
      Moffat Creek ---------- 126
        Southern claims ---------- 126
        Northern claims ---------- 127
      Hayes ---------- 128
        Claim No. 1 ---------- 128
        Claim No. 2 ---------- 128
      Ball ---------- 129
      De Ferra ---------- 129
      Coggins ---------- 129
    Shasta County ---------- 131
      Castle Crag ---------- 131
    Tehama County ---------- 132
      Elder Creek ---------- 132

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* Chief Geologist, Oregon State Department of Geology and Mineral Industries. Manuscript submitted for publication May 18, 1940.

OUTLINE OF REPORT—Continued

DESCRIPTIONS OF THE OREBODIES—Continued

Chromite deposits in the Klamath Mountains—Continued

Page

- Glenn County 133
  - Red Hill group 133
    - Black Diamond claim 133
    - Grey Eagle 134
- Chromite deposits in the Sierra Nevada 134
  - Previous work 134
  - Plumas County 135
    - Quincy group 135
      - Bear claim 135
      - Salt claim 135
      - Salt Extension 135
      - Pepper 135
      - Bald Mountain claims 135
    - El Dorado County 135
      - Pilot Hill 135
      - Pillikin group 136
        - Northwest Basin 137
        - Southeast Basin 137
        - North Central Area 137
        - Steele Property 138
        - Gurney (Darrington) Property 138
        - Main Burnett Property 138
        - Southeastern Railroad Property 138
        - Central Railroad Property 138
        - Dobbas Property 139
- Chromite deposits in southern California 139
  - Previous work 139
  - San Luis Obispo County 139
    - Northwest group 139
      - Sweetwater 140
      - Eureka 140
      - Eagle 141
      - Moonbeam No. 1 141
      - Tip Top 141
      - Chromic Acid No. 1 141
      - Chromic Acid No. 2 141
      - Eucalyptus No. 1 141
      - Eucalyptus No. 2 142
      - Starlight 142
      - Sunrise No. 1 142
      - Sunrise No. 2 142
      - Sunrise No. 3 142
      - Captain 143
      - Colonel 143
      - West Norcross 143
      - Norcross 143
      - Other claims 144
    - Southeast group 144
      - Castro and Castro Extension 144
      - Castro No. 2 161
      - Rawhide 161
      - Estrella 161
      - Mescall 161
      - Unnamed deposits in the SW ¼ Sec. 28 162
      - Niggerhead 162
      - Santa Clara 162
      - Hilltop 162
      - New London 162
      - Trinidad 163
      - Pick and Shovel 163
      - Single Jack 163
      - Chorro Creek claims 164

BIBLIOGRAPHY 165

ILLUSTRATIONS (figures 1 to 31) 145-160

ABSTRACT

This report represents a study made during 1937 and 1938 of approximately 213 separate chromite orebodies occurring in more than 75 separate localities in California.

In all, 99 properties were visited and are discussed in this report.

Klamath Mountains and Coast Ranges
- 15 properties in Del Norte County
- 33 properties in Siskiyou County
- 1 property in Shasta County
- 2 properties in Tehama County
- 2 properties in Glenn County

Sierra Nevada
- 5 properties in Plumas County
- 10 properties in El Dorado County

Southern California
- 31 properties in San Luis Obispo County

An analysis is presented of the structural relationships between individual orebodies and between groups of bodies. This analysis, together with a study of the structures of the orebodies themselves and of the surrounding rocks, is believed to cast further light upon the genesis of chromite deposits, the study of which has heretofore been mainly based on petrography. The results of the study may be summarized as follows:

1. Most chromite orebodies occur in a zone of hydrothermally altered rock, which can be traced for considerable distances through the less altered serpentine, peridotite, or dunite.
2. The altered zones most commonly lie at a slight angle to the trend of the elongated intrusion in which they occur. In several cases there are two sets of intersecting zones which form a diamond-shaped pattern. The orebodies lie within the zones with the larger ones at the intersections. One of the diameters of the diamond-pattern is commonly parallel to the trend of the intrusion.
3. Chromite orebodies are most commonly tabular lenses, frequently pod- or kidney-shaped masses, and sometimes narrow dike-like seams, stringers, or irregular patches.
4. The longer dimension of the orebodies within the zones may lie parallel to the trend of the zone, inclined at an angle to the trend (sometimes slightly overlapping), or even at right angles to the trend.
5. Most orebodies are even-granular massive or even-granular disseminated. They may also be banded, and are infrequently nodular. Certain banded deposits show rhythmic alteration of thin and thick bands of high-grade in a matrix of low-grade ore. Other banded deposits show paired high-grade bands bounded on either side by several bands successively lower in grade.
6. Early hydrothermal minerals are found both included and resorbed by chromite, and cutting chromite as pegmatitic dikes.

Interpretation of these observations indicates that most of the chromite bodies were emplaced late in the magnetic cycle, in some cases while differentiation was still going on. The period of emplacement reached a maximum before or soon after the beginning of serpentinization. The emplacement was governed by well defined zones of strain, which apparently were established at an early date, possibly as soon as the intruded rock solidified. In a few cases the ores seem to be syngenetic with unaltered including rock, and rarely are late hydrothermal and post-serpentinization.

INTRODUCTION

Scope of Report

The following report is a discussion of the geology and origin of chrome deposits found in the Klamath Mountains and Sierra Nevada of California, and in southern California, with especial emphasis upon the structural relationships between the orebodies and associated rocks.

Acknowledgments

From October, 1935, to June, 1938, the writer was engaged in a field survey of the chromite deposits of the three west coast states, made for Mr. C. E. Tuttle, chairman of the Rustless Iron and Steel Corporation of Baltimore, with whose permission this report is being released.

During this period the author was in the field most of the time, and a total of 75 groups of deposits (about 230 separate mineral claims) were visited.

In June, 1938, the writer joined the Oregon State Department of Geology and Mineral Industries as field geologist for eastern Oregon, and was stationed at Baker. The leave of absence which made the completion of this paper possible was granted through the courtesy of Mr. E. K. Nixon, director of the department.

The writer wishes to thank Dr. N. L. Taliaferro, Dr. W. D. Johnston, Jr., Dr. Warren D. Smith, Dr. W. D. Wilkinson, and Mr. H. F. Byram for helpful discussion and suggestions. Mr. Robert Owen has given valuable assistance in the field work. Mr. Howard Stafford and Mr. Ralph Mason are responsible for most of the analytic results, the rest being made in the Baltimore laboratories of the Rustless Iron and Steel Corporation.

It is impossible to acknowledge individually the assistance of the many persons who gave information and acted as guides to the writer, who wishes to express his appreciation here.

GEOLOGIC FEATURES OF THE CHROMITE DEPOSITS

Previous Studies*

The history of the theories developed to account for the origin of chromite deposits falls easily into three periods: the first from 1874 to about 1900, the second from 1900 to 1929, and the third after 1929. Although the third period of thought had its beginnings in 1917 with the papers of Tolman and Rogers (16, 17) it was not until the symposium of 1929-31 (Ross C. S. 29, 31; Singewald, T. J., Jr., 29; Sampson, E., 29, 31, 31a, 32; Fisher, L. W., 29; Keep, F. E., 30) that it was fully crystallized.

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* *Ed. Note:* While this report was in press, two new publications on chromite were issued by the U. S. Geological Survey, one on Seiad (Rynearson and Smith 40), and the other on Pilliken, El Dorado County (Wells, Page, and James 40).

The first period of thought, according to the summary of Harder (Harder, E. C., 10) assumed that chromite was formed during the serpentinization, which up to 1895 (Power, F. D., 99) and even later was generally believed to be a result of weathering. This theory was first formulated by Von Groddeck (79, p. 146), upheld by Power (99) and was still maintained by Beck (05, pp. 8, 27) as late as 1905. Meunier (90) believed that the ores were at least in part a result of pneumatolytic processes occurring shortly after the intrusion of the magma. This is especially interesting to note in view of the later ideas on the subject.

During the second period the theory became well established that all chromite was a result of magmatic differentiation through gravity settling, and that banding was due to primary flow. The work of Vogt (94) initiated this period of thought; and, seconded by Pratt (00), Pratt and Lewis (05), Hall and Humphrey (08a), and Cirkel (09), it became so well established that Rastall (23) in 1923, said that it is "abundantly clear that they (chromite deposits) are in every case original magmatic segregations in rocks of ultrabasic character." Niggli (29, pp. 40, 45, 52, 57, 75), as late as 1929, classified all chromite deposits as "plutonic-ortho-magmatic."

During this interval numerous additions and extensions to this theory developed. Vogt himself believed that there might be schlieren or "veins" of chromite due to serpentinization pressures and extrusion, and was later seconded in this by Harder (10). Van Hise (04, p. 1002) and Gill (22) suggested that this banding might be due to the deformation of the settling layers by movements set up within the magma during slow cooling and crystallization. Grout (18) and Lewis (22) attributed these movements to convection currents, while Knopf (22) and Kato (21) considered them to be primary.

The third and latest period of thought was initiated by the papers of Tolman and Rogers (16), who held that many sulfides and some magnetite and chromite deposits are formed by the introduction of metallic minerals in solution at a period later than the original crystallization of the rock, yet within the magmatic period. Although the oxidic ores preceded the sulfides in the order of deposition, the action of mineralizers kept them in solution until after the rock-forming minerals had solidified. Ore deposition then took place through the introduction of these constituents into the already solidified silicate minerals and at their expense.

Singewald (17) immediately seconded these views and applied them more specifically to chromite deposits. A statistical survey and analysis of basic intrusions by Hulin (29) still further emphasized the importance of volatile mineralizers given off by basic magmas in delaying the deposition of the "magmatic" ores.

In his study of the chromite deposits in the Klamath Mountains, Diller (21, pp. 15-25) summarized the views held up to that time, and concluded that although the chromite of that region is of primary magmatic origin, the time of its appearance in the magmatic series was still in doubt, being only bounded by appearance of veins of chrome silicates which seem to show approximately the limits of the magmatic and hydrothermal periods.

As a result of the development of these new concepts concerning the origin of chromite, a symposium was held by the journal Economic Geology, in 1929-31. Here and elsewhere Sampson (29, 31, 31a) and Fisher (29) established criteria classifying the deposits into early magmatic, late magmatic, and hydrothermal; and Ross (29, 31) developed five possible theories of origin.

Sampson believed, after studying South African deposits, that these deposits could be explained only by the remelting of sorted crystals or by separate intrusions of magma, due to simultaneous formation of chromite and silicate from the residual solution.

The consensus at this time, as later outlined by Maxson (33, 33a), seems to have been that some of the deposits are early magmatic, most of them late magmatic although probably continuous in development with the early, and some of the smaller deposits are hydrothermal in origin. Papers by Rogers (32) and Johnston (36, 36a) on the internal structures of chromite deposits also confirm the theory of a late magmatic origin for a large part of the chromite of the Klamath Mountains.

Characteristics of the Orebodies

In spite of the voluminous nature of the chromite literature, little attention has been paid to the large-scale structural features of the deposits and the relations of adjacent deposits to each other. As this study of West Coast chromite progressed it became apparent to the writer that an analysis of these features might lend further valuable evidence as to the origin of the deposits.

Each group of deposits studied has been analyzed as to number, size, shape, and attitude of the orebodies; and as to degree of serpentinization of the country rock and kinds of structures within the orebodies. The terms used in this analysis are defined as follows:

1. *Number*

(a) Number of localities: When adjacent deposits in a group lie more than a quarter of a mile apart, they are counted as occurring in separate localities.

(b) Number of orebodies definitely in place in the country rock.

2. *Size of orebodies*

(a) Small: less than 10 tons: Orebodies from which less than 10 tons have been mined, or those whose average surface exposure is less than 10 square feet.

(b) Medium: between 10 and 100 tons: Orebodies from which more than 10 and less than 100 tons have been mined, or those whose average surface exposure is from 10 to 100 square feet.

(c) Large: greater than 100 tons: Orebodies from which more than 100 tons have been mined, or those whose average surface exposure is more than 100 square feet.

3. *Shape of orebodies*

(a) Seams and stringers: Orebodies whose length on the exposure is more than 10 times the average breadth, which is less than 6 inches.

(b) Bands and flat, tabular lenses: Orebodies whose average length on the exposure is more than five times the average breadth and whose extremities usually pinch out gradually.

(c) Kidneys or pods: Orebodies whose average length on the exposure is less than five times the average breadth and which characteristically have more or less rounded terminations.

(d) Irregular: Orebodies whose irregularity of outline or exposure prevents classification in the above groups.

4. Attitude of the major axes of orebodies

(a) No zone seen: There is no visible relationship between or alignment of adjacent orebodies, and there is no well-defined zone of hydrothermal minerals in the country rock.

(b) Parallel to line of zone: Three or more orebodies appear on the surface in a more or less straight line, with the length of each orebody parallel to that line; or one or more orebodies occur lying within an altered or otherwise well-defined zone in the country rock, with the length of each orebody parallel to the zone.

(c) En echelon in line of zone: Three or more orebodies appear on the surface in a more or less straight line, with the length of each orebody at an angle of less than 45° to that line; or one or more orebodies occur within an altered or otherwise well-defined zone in the country rock, with the length of each orebody at an angle of less than 45° to the zone.

(d) Normal to the line of zone: Three or more orebodies appear on the surface in a more or less straight line, with the length of each orebody at an angle of over 45° to that line; or one or more orebodies occur within an altered or otherwise well-defined zone in the country rock, with the length of each orebody at an angle of over 45° to the zone.

(e) Parallel to each other in zone: Two or more orebodies occur with their lengths parallel to each other and to the including zone.

(f) Irregular in zone: The outlines of the orebodies within a zone are too irregular or otherwise obscured to be classified.

5. Degree of serpentinization of country rock

(a) Intense: No unaltered olivine is visible with the hand lens in the country rock. Usually jointing and fracturing has a texture of less than 2 inches.

(b) Moderate: Unaltered olivine can be detected with a hand lens in the centers of larger blocks, although serpentinization is fairly complete. Usually jointing and fracturing has a texture of 2 to 10 inches.

(c) Slight: Unaltered olivine makes up most of the country rock, alteration being restricted to joint planes which usually have a texture of over 10 inches.

6. Structures within the ore

(a) Even granular, massive: Closely packed hypidiomorphic grains, usually from 0.5 to 2.0 millimeters in diameter (although sometimes aphanitic or very coarse) with small amounts of interstitial olivine, pyroxene, magnesite, kammererite, or serpentine minerals.

(b) Even granular, disseminated: Subhedral to euhedral chromite grains, evenly distributed through pyroxene, olivine or serpentine to make up from a trace to about 80 per cent of the rock.

(c) Banded: Parallel layers commonly from 1 to 60 millimeters thick of sometimes massive but more commonly disseminated ore, with percentage of contained chromite crystals varying between adjacent bands.

(d) Nodular: Spherical or slightly ellipsoidal aggregates of anhedral to subhedral chromite crystals varying from 2 to 15 millimeters in diameter. The elongated or lenticular bodies are usually parallel in orientation, and the bodies are surrounded by pyroxene, serpentine, or olivine, which sometimes also contain slight disseminations of chromite crystals.

7. *Secondary chromite*

Joint and shear planes in serpentine adjacent to the orebodies are covered with paper-thin layers of chocolate-brown aphanitic chromite. Chromite is contemporaneous with or later than the late hydrothermal minerals, chlorite, talc, kammererite, magnesite, etc.

In the following statistical summary each individual orebody has been classified and totaled under the various regional groupings.

SUMMARY OF STRUCTURES

	1		2			3				4						5			6				7
	a	b	a	b	c	a	b	c	d	a	b	c	d	e	f	a	b	c	a	b	c	d	
DEL NORTE AND SISKIYOU CO.—																							
High Plateau	1	4?		1	4		1	3?			3?	1						1	1				
Gasquet Group	5	8	15			2	2	2		4	3					5			2	4			
Soldier's Wells Group	3	6	1	2	3		2	4			3			3		1			1	1			
Zinc Saddle	1	3	1	2		1	?	?			3						1		1	1			
Hawkins	1	3		2	1			3					3			1			1				
Camp 7	3	2	1	1	1	2		2		3						2		1	3				
Camp 8	1	3		2	1			?			?					1			1				
Youngs Valley Group	3	5			5			5		5								3	3	1			
North of Seiad	2	2			2		1	1		1	1			1				1	1	1	1		
Seiad Valley	1	5?			5?		5				3			3				1	1	1	1		
Hamburg	2	7	3		4		7					5						2	1	2			
South Moffat Creek	4	6	3	3				6			2	4						4	4				
North Moffat Creek	9	9	7			6	2	2			4	4			1	8			9	1	2		
Hayes	2	4	3						?	?						2				2			2
Bell	1	5	5					5			?					1			1				
De Ferra	1	2		2			2				2					1			1				
Coggins	1	4?		1	3?		2	2?				3?		1				1	2	2			
Castle Crag	2	3		1	2		1	2				3						1	1	1	1		
NORTH COAST RANGES—																							
Elder Creek	1	2		1	1		1	1			2					1			1	1			
Beegum Creek	1	2			2			?				?				1			1				
Red Hill Group	2	11	2	2	7	4	3	4			?	5		4				2	2	2	1	1	
Heifer Camp Creek	3	3		2	1		3				3							3		3			
SIERRA NEVADA RANGE—																							
Quincy Group	3	2	2			2				2	1						1		1				
Pilot Hill	1	2	2			2				2						1			1				
Pillikin Group	9	47?	19	14	13	4?	33	6?	2	3	34	3	5	3?		5	2		3	8	2		
SOUTHERN CALIFORNIA—																							
Northwest Group	15	43	35	12	6	13	25	3	11	6	17	6	1	5		12		1	11	10	5	1	1
Southeast Group	8	25	14	9	4	3	13	11	5		16	4		4	1	8			7	6	5		

SUMMARY OF STRUCTURES

	Del Norte and Siskiyou counties	Northern Coast Ranges	Sierra Nevada Range	Southern California	Total California	Total West Coast
1. NUMBER—						
a. Localities	43	10	10	23	86	234
b. Orebodies in place	81	20	49	63	213	442
2. SIZE—						
a. Small	39	4	21	49	113	285
b. Medium	17	5	14	21	57	115
c. Large	31	11	13	10	65	108
3. SHAPE—						
a. Seams and stringers	16	6	6	16	44	90
b. Bands and lenses	26	7	33	38	104	175
c. Kidneys and pods	39	6	6	14	65	147
d. Irregular	1	--	2	16	19	63
4. ATTITUDE—						
a. No zone or alignment	14	2	5	6	27	56
b. Parallel to zone	23	7	34	33	97	176
c. En echelon to zone	22	6	3	10	41	76
d. Normal to zone	4	--	5	1	10	14
e. Parallel to each other	8	4	3	9	24	49
f. Irregular in zone	1	--	--	1	2	52
5. SERPENTINIZATION—						
a. Intense	22	2	6	20	50	121
b. Moderate	1	1	2	--	4	59
c. Slight	15	5	--	1	21	34
6. INTERNAL STRUCTURES—						
a. Massive	34	5	4	18	61	181
b. Disseminated	17	6	8	16	47	98
c. Banded	5	1	2	10	18	34
d. Nodular	--	--	1	1	2	6
7. SECONDARY	2	--	--	--	2	15

Discussion of Genetic Features

Certain characteristic features of chromite deposits become apparent through a study of the foregoing chart. Chromite bodies seldom occur singly. Over 440 individual bodies were seen at 234 West Coast localities, and even this average of two to each locality does not adequately reflect the grouping of deposits. The deposits listed were only those outcropping at the surface. They represent two dimensions of a three-dimensional picture. If float occurrences indicating further bodies had been added to the estimate, it would have raised the average to nearly four to one.

Large orebodies are frequently accompanied by satellitic smaller deposits, but the ratio of small to large is only two or three to one, and many large deposits have no associated smaller ones nearby.

The most common shape of a chromite orebody is that of a flat lens, lentil, or tabular body. The blunter and thicker kidney or pod shape is almost as common, while seams and stringers and irregular bodies are seen much less frequently.

Practically all the orebodies have steep attitudes, usually dipping well over 60°. At Red Hill the gentle westward dip of the lenses is accounted for by the later eastward tilting of the rocks of the range, as shown by the steeply east-dipping Knoxville a few miles from the deposits.

In the rather extensive literature on chromite deposits there are numerous discussions of banding in the ores (Vogt, J. H. 94, p. 389;

Van Hise, C.R. 04; Grout, F.F. 18a; Kato, T. 21; Gill, A.C. 22; Johnston, W.D., Jr. 36), but only a very few references to other field relationships, such as the relative positions and attitudes of associated orebodies. Lewis (22, p. 134) mentions that the orebodies of South Carolina ''are commonly associated . . . in various ways—for example, they crop out in a line or in some parallel arrangement, as side by side or overlapping or steplike (en echelon),'' and Maxson (33) notes that the ore lenses are apparently oriented by orogenic forces during formation.

Fully 75 percent of the orebodies noted in this examination show some definite relationship to adjacent deposits, and in only 50 of the 234 localities is such a relationship ruled out. It is the rule rather than the exception to find adjacent orebodies lying within a more or less well-defined zone of shearing and alteration in the country rock, or to find them lying in a more or less straight line.

These zones have constant trends over considerable distances and sometimes occur in two intersecting sets, suggesting regional structural control which could not have been effected before the cooling of the upper part of the intrusion. Serpentinization and hydrothermal action have often been more or less localized among these zones. The orebodies themselves do not seem either extensive or continuous enough to have caused the localization of the shearing and metamorphism.

On a petrographic rather than a structural basis, Sampson (32) proposes the classification of chromite deposits into three types:

> "I. Chromite formed earlier than olivine or contemporaneous with it, and in part included in olivine grains.
> II. Chromite formed at a late magmatic stage, and crystallizing with the last truly magmatic silicate, commonly either bronzite or plagioclase.
> III. Chromite formed from hydrothermal solutions, for the most part immediately preceding or contemporaneous with intense serpentinization."

Fisher (29) divides the third period, depending upon whether the chromite is associated with early hydrothermal minerals (anthophyllite, actinolite, tremolite) or late hydrothermal minerals (chlorite, talc, kammererite, penninite, serpentine and magnesite). He concludes that the chromite is formed in greater quantity during the late magmatic or deuteric period, where it replaces groundmass minerals. Sampson states that

> ". . . although much chromite may crystallize at a very early stage, a substantial amount of the constituents of the mineral passes into a residual solution and even into a highly aqueous solution capable of considerable migration."

A study of the large-scale structural relationships of the West Coast deposits seems to bear out in most essentials, with evidence from an entirely different direction, the conclusions of these authors.

Of over 400 chromite orebodies, nearly half are elongated parallel to the trend of the zone in which they lie. Movement along an irregular fault plane forces the walls of the plane apart and forms spaces which can be filled by ascending solutions. The mechanics of this process are discussed by Hulin (29a) and figured by Johnston (36a, p. 32). The filled spaces in quartz lodes, known as ore-shoots, have the characteristic flat lens shape most frequently encountered in chromite deposits.

In at least 19 localities studied, the chromite lenses lie overlapping each other or en echelon, usually at a small angle to the trend of the zone in which they lie. The pattern of open gash fractures forming near a plane of weakness within which fault movement has taken place is figured by Gilbert (see figs. 1 and 2) and noted by Nevin (see fig. 3). Looking along the fault, if the left-hand side has moved away from and the right-hand side toward the observer, the gash fractures always trend away from him on his right and toward him on his left. Nevin (see fig. 3) notes that in regard to the diagrams:

> "It would seem more logical to use the stresses that are responsible for the regional dip as a control of the trend of the fault belts, rather than buried lines of weakness which might have little relation to the regional dip."

Similar open gashes or tension joints are figured by Leith (see fig. 4) as occurring in an incompetent shale band lying between massive quartzites; the gashes cross the curved fracture cleavage in the shale. Similarly oriented fractures on a large scale are noted by Chamberlain (19) who explains an east-west belt of oblique en echelon faults in Montana as the result of movement of the areas on either side in opposite directions. Sherrill (29, pp. 31-37) also believes that belts of en echelon faults in north-central Oklahoma are shears produced by torsional stresses, combined with simple tension.

Overlapping or en echelon chromite bodies are best developed in California at Red Hill and Sweetwater. If the preceding assumptions and correlation are correct, the north and east sides of the zones at Sweetwater and Red Hill have moved to the south and east.

At one locality (High Plateau) in California, and in others in Oregon, ore lenses cut directly across the zone and through other orebodies lying parallel to the zone. If the main orebody at this locality is due to infilling of openings produced by movement along an irregular fault, then the later cross-cutting lenses can have been produced by gash openings along the same fault when movement has been renewed after emplacement of the first orebody.

With one exception, none of the chromite deposits studied could, on the basis of megascopic evidence, be definitely placed in the category of magmatic segregations in place.

At the Black Eagle claim north of Seiad, in a country rock showing numerous splatters of ore and disseminated crystals, a wide ''dike'' of banded ore shows a rhythmic repetition of paired bands, each wide band next to and overlying a thin one (See fig. 5). The bands of high-grade have open vugs with large kammererite crystals, the largest seen anywhere by the writer.

It is very hard to visualize any possible way in which such a structure could be ''intruded'', or formed by hydrothermal replacement; and its strong resemblance to banding produced by ''rhythmic differential settling'' as proposed in 1936 by Coats (36) can not be overlooked. He discusses in this paper the hypotheses previously proposed to account for these phenomena by Hall (08), Bowen (28), Grout (18a, pp. 441-457), and others. The occurrence north of Seiad seems to have resulted from early magmatic segregation of some sort.

The contacts of the large disseminated and banded deposits are nearly always sharp enough so that any gradation can be explained by replacement.

One occurrence at Hamburg is of particular interest. The banding in this deposit was believed by Diller (21, p. 18) to have originated ''under the same conditions that induced the development of the associated gneiss''. He concluded (21, p. 24) that ''as urged by Van Hise (04) the gneissic structure may be developed by differential stress during the slow cooling and crystallization of an intruding magma''.

The specimen pictured in figure 6 is made up of parallel paired bands of ore, with the highest-grade pair in the center and successively lower-grade bands occurring outward in either direction. Although not complete in this specimen, the relationship holds generally true in a number of spots in this deposit. In figure 7 a later band is seen cutting across those of previously formed lower grade. In figure 8 bands are contorted by later movement.

This deposit seems to have originated either through a series of late magmatic pulsating intrusions of increasingly enriched ore in the form of a ''crystal mush'' (Bowen, N. L. 28), or through early hydrothermal replacements by successively more and more highly concentrated solutions.

Thus far we have been discussing the orebodies themselves and their relation to the zones in which they lie. On a larger scale it seems possible to connect the location and attitudes of the orebodies within the zones to regional movements originating outside the ultra-basic intrusions.

In two areas (Moffat Creek and Pillikin) two sets of parallel intersecting zones could be distinguished, with the larger orebodies tending to lie at the intersections, parallel to one of the sets and normal to the other. At Pillikin the zones strike N. 20°W. and N. 85°E. (see fig. 9) while the serpentine-amphibolite contacts run a little east of north. At Red Hill and at Sweetwater (see fig. 10) the main zone-trend more or less parallels the outer contacts of the elongated serpentine bodies, which in the latter strike N. 45° to 60° W. The cross zones at Sweetwater strike N. 20°E.

The longest dimension of the serpentine and peridotite bodies in these areas (and others) is parallel to the axes of folding and schistosity of the adjacent older rocks. If the compressive forces normal to these axes, which folded the older rocks, were active when the ultrabasic magma had begun to solidify, the strain patterns noted as zones would normally result. As soon as the cooling of the outer portion of the intrusive had progressed to a point where the stresses could no longer be relieved by flow—the change from the ''plastic'' to the ''rigid'' stage of Johnston and Cloos (34, pp. 51-52)—fracturing would occur in some such pattern as that actually shown by the ''zones''.

Serpentinization has been regarded as the result of hydrothermal metamorphism of ultra-basic rocks by Weinschenck (16), Merrill (99), and Benson (18); although the time of this change is still somewhat in question. In a more recent study by Hess (33), it is argued that the serpentine is autometamorphic and pre-hydrothermal, occurring as the intruding magma picks up water from the country rock. The intrusive will not necessarily expand during this process. Bain (34) believes that serpentinization is hydrothermal and not associated with the deuteric activity of the parent magma.

If serpentinization involves a change in volume it might be argued that the sheared zones are the result of the resulting endogenous stresses; but if this were the case large-scale strain-patterns conforming to those which would be formed by the regional compressive stresses should not appear. Since altered zones occur on both unaltered and serpentinized rocks, they may have been initiated as soon as the magma had solidified; and the occurrence of late hydrothermal minerals in them indicates that they were active at a very late stage.

Schafer (37, p. 10) notes that in Montana a correlation exists between the degree of serpentinization and the shape of the orebodies:

> ". . . The distinction between the lenticular deposits of the highly metamorphosed serpentine areas and the continuous layers in the unmetamorphosed rocks is important from the standpoint of mining and the calculation of ore reserves."

This correlation does not appear in the analysis, although in certain areas (Moffat Creek as opposed to Hamburg and Seiad) it is well defined.

In a primarily economic survey it was not always possible to determine the relationship of the chromite deposits to the contacts of the ultra-basic intrusions with the older intruded rocks. Most of the chromite deposits lie deep within the intrusions and far from their contacts, although in several localities, the orebodies lie within a few hundred feet of the outer contact of the serpentine or peridotite. In most of these cases the ultra-basic bands are very narrow.

Orebodies are sometimes found within a short distance of contacts of serpentine with zenoliths or inliers of schist, chert, or quartzite. Although these bodies and contacts might have acted as "settling tables" for the collection of gravity-differentiating chromite crystals, a more probable explanation is that the more competent inliers and adjoining country rocks acted to localize the stresses which formed the zones, so that they developed near the inliers. The fat pod-shape of the orebodies is strong evidence against the first hypothesis.

Acidic dikes are found paralleling zones and chromite bodies, but it is probable that these were later intrusions following the preexisting lines of weakness.

Traces of secondary chromite are present in highly serpentinized areas but the orebodies themselves seem to have been emplaced before or soon after the beginning of serpentinization, and to have been sheared and broken by that process. Hydrothermal minerals, such as kammererite, in the interstitial gangue of high-grade ore, may have formed either during the emplacement of the ore or later, altering previous gangue minerals.

By far the greater number of the deposits seem to have been emplaced in fractures in already more or less consolidated rocks, after partial cooling of the peridotites and before most of the serpentinization.

Summary of Conclusions

An analysis of the structural relationships between individual chromite orebodies and groups of orebodies at some 234 localities on the West Coast is believed to cast further light upon their genesis, the study of which has heretofore been mainly confined to petrographic methods.

1. Most chromite orebodies occur in a zone of hydrothermally altered rock, which can be traced for considerable distances through the less altered serpentine, peridotite, or dunite.

2. The altered zones most commonly lie parallel to or at a slight angle to the trend of the elongated intrusion in which they occur. In several cases there are two sets of intersecting zones which form a diamond-shaped pattern. The orebodies lie within the zones with the larger bodies at the intersections. One of the diameters of the diamond pattern is commonly parallel to the trend of the intrusion.

3. Chromite orebodies are most commonly tabular lenses, frequently pod- or kidney-shaped masses, and sometimes narrow dike-like seams, stringers, or irregular patches.

4. The longer dimension of the orebodies within the zones may lie parallel to the trend of the zone, inclined at an angle to the trend (sometimes slightly overlapping) or even at right angles to the trend.

5. Most orebodies are even-granular massive or even-granular disseminated. They may also be banded, and are infrequently nodular. Certain banded deposits show rhythmic alteration of thin and thick bands of high-grade in a matrix of low-grade ore. Other banded deposits show paired high-grade bands bounded on either side by several bands successively lower in grade.

6. Early hydrothermal minerals are found included and resorbed by chromite, and cutting chromite as pegmatitic dikes.

The sequence of events is interpreted to have been somewhat as follows:

1. Ultra-basic magma is intruded in long sill-like masses into older rocks. Although differentiation of chromite may begin before intrusion, it is more likely that it takes place during and even after intrusion.

2. As soon as the margins of the intrusion solidify, compressive stresses establish well-defined zones of strain, in parallel or intersecting sets of faults.

3. Movements along these fault zones permit introduction of chromite-rich ''crystal mush,'' or hydrothermal solutions. The process may be initiated while differentiation is still active, or while the solutions are becoming more and more highly concentrated.

4. Stresses along many of the fault zones may result in gash-joint openings in en echelon series, producing the overlapping lenses of high-grade ore.

5. The larger orebodies are most frequently found at the intersection of the fault zones, as in other types of mineralization.

Most of the chromite orebodies thus seem to have been emplaced late in the magmatic cycle, after partial consolidation of the rock, and contemporaneous with the early deuteric activity of the magma. The period of their emplacement reached a maximum before or soon after the beginning of serpentinization. In a few cases the ores seem to be syngenetic with unaltered including rock, and rarely are late hydrothermal and post-serpentinization.

DESCRIPTIONS OF THE OREBODIES

CHROME DISTRICTS IN CALIFORNIA

Chrome-producing districts studied in California are three in number: (1) Klamath Mountains and northern Coast Range district, which includes parts of Del Norte, Siskiyou, Shasta, Tehama, and Glenn counties; (2) Sierra Nevada district, which includes parts of Plumas and El Dorado counties; and (3) Southern California district, located mostly in San Luis Obispo County.

CHROMITE DEPOSITS IN THE KLAMATH MOUNTAINS

Previous Work

Chromite-bearing rocks are widely scattered throughout the physiographic and geologic province of the Klamath Mountains. The geology of this region was first outlined by Diller (02, 03, 14; Diller and Kay 09, 24), who is also responsible for the most comprehensive study of the chromite resources of the region (20, 21).

In California, areas within the Klamath Mountains have been studied and mapped by Averill (31), Maxson (33a), and Hinds (33, 35); and the chromite deposits have been studied by Diller (18, 19, p. 2018), Van Fleet (17, p. 293), Logan (18, pp. 101-228), Rogers (32), Maxson (33a), and Johnston (36).

Description of Klamath Mountains Province

The rocks of the Klamath Mountains province are the oldest in northern California and western Oregon, and are probably related to those of the Blue Mountains of eastern Oregon and the Sierra Nevada of California. In age they are predominantly Paleozoic and Mesozoic, ranging from pre-Devonian to Cretaceous; in type they are highly diversified, varying from schists and meta-volcanics, slates, sandstones and limestones, to acid and basic intrusive igneous rocks.

The basic intrusives, consisting of gabbros, peridotites, dunites, and serpentines, occur in north-south trending bands from a few yards to 20 miles in width, and up to 50 miles in length. These rocks are bounded by older sediments and metamorphics into which they have been intruded, probably in late Jurassic time. It is exclusively in these rocks that the chromite deposits are found.

The Klamath Mountains province is one of predominantly high relief and rugged character. The differences in elevation between the beds of the main rivers (Rogue, Klamath) and the ridge tops are well over 3,000 feet. The valleys, with few exceptions, are in the stage of topographic youth. Remnants of an old erosion surface remain in the western portion of the area at elevations varying from 3,000 to 4,000 feet, and a series of raised sea beaches up to 1,500 feet in elevation can be identified in places along the coast, corresponding to at least three erosional stages visible in the drainage profiles of the larger streams.

Del Norte County (See Fig. 11)

*High Plateau (1)**

High Plateau is located in the NE¼ Sec. 28, T. 18 N., R. 2 E., H., one mile northwest of High Plateau lookout station, 28 miles from the Redwood highway at O'Brien.

The country rock consists of peridotite porphyry or "buckskin," occurring on the surface as large blocks or boulders, and occasionally in place as cliffs. Within this rock lie narrow zones altered to green serpentine with white magnesian veinlets.

The main orebody before mining consisted of a series of at least five closely adjacent and overlapping lenses, whose total length was at least 120 feet, with thickness 8-12 feet. They have been mined to a depth of over 40 feet. This body strikes N. 65°—85° W., and dips from 0-45° NE.

Near the center of the main lens a smaller narrow lens about 2 feet wide and 10 feet long of a different type of ore cuts through and branches away from the main body at an angle striking N. 60° W. and dipping 55° NE. A chromite zone runs N. 60° W. from these workings, small float being found 200 feet away in this direction. Small ore croppings also appear on the other side of the ridge.

Four hundred feet below and 1,000 feet to the S. 25° E. lies a bench, perhaps 150 feet above the creek bottom, with a relatively flat top perhaps 300 feet wide and 300 feet long. The top of this bench is covered with chromite boulders and sand. In some areas the boulders lie so closely spaced that they constitute the only rock appearing. These areas have a tendency to be elongated in a northeasterly direction, suggesting the attitude of the orebodies above. On the steep slope separating the bench from the deposits above, float is relatively scarce and consists mostly of large boulders (up to 2 feet in diameter) which appear to have rolled from above. Test pits 2 feet square have been dug on the surface of the bench; and while ore is not found as thickly as on the surface, boulders are also present throughout the soil.

Considering the position of the bench, the steepness of the slope from the north, and the distribution of the ore on the bench and slope, it is logical to assume that the bench is essentially a landslide block which rode downhill on an even keel and much in one piece, retaining the level surface which characterizes the surface of the ridge above. A complete analysis of the ore is as follows:

	Percent
Cr_2O_3	53.65
FeO	13.75
SiO_2	6.36
MgO	6.00
Al_2O_3	10.60
CaO	5.19
MnO	.20
Miscellaneous	4.25
	100.00

The 2,500 tons shipped from this property ran 52 percent Cr_2O_3 in 500-ton lots. It is extremely coarse-grained equigranular (crystals up to 7 millimeters diameter) with a small amount of white magnesite, uvarovite, and kammererite. The ore from the small lens is of a different type, fine-grained and dense aphanitic, and assays 33 per cent Cr_2O_3 and 18 percent FeO. The ore on the bench below appears to be mostly of the coarse-grained type (see figs. 12, 13).

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* Numbers after names of claims correspond with numbers on map, figure 11.

Maxson (33a, p. 153, fig. 21) discusses this property and gives a photograph of the workings.

Gasquet group (2)

Fairview is located a quarter of a mile airline south of the Redwood Highway and about 400 feet above, due south of the Gasquet post office, which is about 18 miles east of Crescent City, California, near the center of the W½ Sec. 30, T. 17 N., R. 2 E., H.

There are four open cuts on this claim showing ore, but in none of them is the ore band over a foot wide. The country rock is a white-weathering highly serpentinized rock with numerous white veins and bands of tremolite. Near the ore the rock varies to an aphanitic green-gray rock, probably altered dunite.

Cut No. 1 on top of the north-sloping ridge exposes ore for 5 feet along the southwest side and bottom of the cut. The width is small and indeterminable; the quantity of the ore is probably small.

Cut No. 2 lies 750 feet south up the ridge. It is 10 feet long and runs across the ridge, exposing a low-grade band from 4 to 8 inches wide in altered dunite.

Cut No. 3 lies 75 feet west of No. 2, and runs east into the hill for 40 feet. About 6 tons of ore have been mined and piled. None shows in place.

Cut No. 4 lies 300 feet farther west. It exposes a lens 24 inches wide, from which 3 tons have been mined and left piled. A tunnel in which ore is said to be exposed is now caved. The ore is of quite low grade, and probably will average less than 35 percent chromic oxide. The ore in cut No. 4 is of even lower grade.

Margy is located just west of the Fairview claim, running southwest to west line of Sec. 30.

At cut No. 1 about 200 pounds of ore have been mined; none could be seen in place. At cut No. 2, which lies 500 feet to the north, about 3,000 pounds of ore lie piled by a large caved cut. This appears to be about 35-40 percent chromic oxide. At cut No. 3 which lies 100 feet downhill west of No. 2, about 500 pounds of ore have been mined, and a very small patchy outcrop with a maximum width of 6 inches is exposed.

Niggerhead is located about one mile due north of Gasquet, between the lower and upper switchback on the Low Divide trail, in the NE ½, Sec. 19, T. 17 N., R. 2 E., H.

The workings lie about 600 feet above the trail, and are connected by a string of small float extending for at least 300 feet N. 20° W. in a sheared talcose zone from 10 to 30 feet wide. The country rock is a dark-green to black serpentine, with much light-colored pyroxene in stringers. The surface weathers to bluish gray.

Several small opencuts expose ore along this zone. The chromite in place was in small bodies and the grade was medium. About one ton of 40-50 percent chromic oxide content ore has been mined at the southern cut. The body is here from 10 inches to 2 feet thick, and not very extensive.

Large water-worn float boulders of chromite lie on the ridge top 30 feet above to the west and also to the north, and a string of float also leads down to the creek bed 50 feet below. In the east wall of the creek 200 feet upstream and 10 feet above the water, a kidney measuring 4 by 4 feet lies in a serpentine breccia.

Another large cut lies 400 feet due east of the first one, near the bottom of the second gulch. About 6 tons of medium-grade ore are piled by this cut, and no ore is to be seen in place. The ore is crusted and cut by serpentine stringers and has to be carefully cobbed and sorted.

Angela is located near the center of the NW¼, Sec. 17, T. 17 N., R. 2 E., H., about 3,000 feet northeast of Niggerhead claim.

Four now very badly caved pits were dug in a gray serpentinized peridotite. The overburden is very thick, the soil a dark red. The rock is much cut with chrysotile veinlets. The pits run N. 45° W. for about 150 feet.

Only one narrow stringer of ore was seen in place, but about 16 tons of ore lie piled by one of the pits, and more is said to have been taken out by packhorse. The ore appears to be high-grade, with some low-grade.

Blackjack is located about 1,000 feet southeast of the Angela claim, half a mile northwest of the mouth of Stoney Creek, and 1,500 feet above the river, in the NW¼SW¼, Sec. 17, T. 17 N., R. 2 E., H.

Two cuts have been dug about 600 feet apart on an east-west line. Ore shows in the face of the eastern (lower) cut, but its attitude or amount is not exposed. Heavy float is found down the hill to the east for a thousand feet, and may total 10 tons in all.

The western cut is about 30 feet long by 10 feet wide, from which about 27 tons of medium-grade ore have been mined and left piled by the cut. The ore is coarse-grained and friable. No ore was to be seen in place.

Soldier's Wells Group (3)

Soldier's Wells group is located in the W½, Sec. 15 (Deposit C) and Sec. 16, T. 15 N., R. 2 E., H., Del Norte County. Deposit A is located 1½ miles south of Rattlesnake lookout on the only road, a quarter of a mile northeast of Soldier's Wells. Deposit B is half a mile northeast of Deposit A at the end of the road. Deposit C is a quarter of a mile to the east and perhaps 200 feet lower than Deposit B. It is reached by a road branching off half a mile south of the lookout. All lie on or near the summit of the "Klamath peneplain".

The country rock is the red- to yellow-weathering diallage-peridotite generally distributed throughout this region. Variations of type show mega-porphyritic and equigranular faces, as well as fine chrysotile veination and slight serpentinization in rather narrow zones.

Deposit A. The ore seems to lie in three north-striking lenses, probably standing nearly vertical, and averaging 45 feet apart. Most of the ore mined came from the two western bodies, the center one having been developed by a shaft of unknown but not great depth which went down an orebody which still shows on the south wall as 3 to 4 feet wide, probably vertical, striking north. This was the only ore seen in place at Deposit A.

Deposit B. This lies about a quarter of a mile to the northeast on the edge of the plateau, and consists of a series of at least four deposits, lying in a northwest line for nearly 200 feet, generally striking in a northerly direction, and dipping steeply to the northeast. They may lie more or less en echelon, but only tens of feet apart and parallel. None of them appears to have been mined to a depth exceeding 15-20 feet. Most of the kidneys seem to have averaged 1 to 4 feet in width and 15-25 feet in length. Ore is not now apparent in any of the caved openings.

Deposit C. This lies about a quarter of a mile to the northeast of Deposit B, and 200 feet down the steep eastern slope of Rattlesnake Plateau. The deposit was at least 5 feet thick in solid ore, the top surface of the kidney striking N. 75° W. and dipping 30° S. into the hillside. It is only exposed for 15 feet at the most, and must have been mined to a depth of 25 feet in order to yield the 200 tons of ore piled, although the tunnels (if there were any) are caved. The other possibility is that the body stood out prominently. A pillar 5 feet high and 6 feet wide, exposed to a depth of 8 feet, has been left in place near the center of the cut.

Chip samples were taken at intervals of a few feet over the entire surface of all the ore piles, assaying as follows:

	Cr_2O_3
Soldier's Wells (A)	41.83
Soldier's Wells (B)	40.04
Soldier's Wells (C)	40.84

The ore is coarse-grained, with only a small amount of interstitial gangue.

From the highway to Rattlesnake lookout, it is 16 miles by a third-class upper forest road, and about the same distance by the slightly better lower road which joins it 4 miles north of the lookout. From the junction of the Rattlesnake road with the highway, it is 10 miles to Crescent City and 76 miles to Grants Pass, Oregon.

Zinc Saddle (5)

Zinc Saddle is located in the SE¼ Sec. 26, T. 17 N., R. 2 E., H., Del Norte County. The workings lie just a quarter of a mile N. 20° W. of the saddle crossed by the Gordon Mountain road west of Cedar Spring.

The "Saddle" is the result of erosion of a zone of sheared serpentine lying between more resistant peridotite porphyry. This zone strikes N. 15-20° W. and dips 45° W. Small outcrops of ore appear along this zone for over half a mile, both south of the saddle and to the north, where for 200 feet it has been prospected by five cuts, one of them 50 feet and another 30 feet in length. No ore was seen in place, although both high- and low-grade ore was piled at the mouth of the more or less caved cuts.

Hawkins (4)

Hawkins lies 100 yards north of and below the trail, in SW¼NE¼ Sec. 19, T. 16 N., R. 2 E., H., Del Norte County.

The claim is located near the top of an east trending ridge, on a fairly steep 25° north slope, in a country rock of serpentinized peridotite and dunite, much cut by veins of chrysotile, and less porphyritic in nature near the deposits. Some of the rock is very platy, indicating movement which is also reflected in small offsetting faults in the north orebody.

The three main cuts which expose at least two, and possibly other orebodies, are aligned north-south up and down the hill, a total distance of 66½ feet from the extreme ore exposures, and a difference in elevation of 25-30 feet.

The lowermost cut is floored by ore, and its face, exposed for 16 feet in length and 5½ feet in height, is also solid chromite. At the east end, however, the body appears to round off, and at the west end is dipping gently westward when it disappears. The indication is that the kidney has a cross-section of at least 20 by 10 feet and possibly much more, plunging gently southwest. The east end is broken by several closely spaced faults with displacements of only a few inches.

The central cut lies 40 feet up the hill, and although large blocks of ore were seen in its face, none of them are certainly in place.

The upper cut lies only 15 feet farther south, and exposes a small body 8 feet long by 4¼ feet wide, whose east side strikes N. 20° E. and dips 60° E., and whose south side strikes east and dips 55° south. It can be seen that if these boundaries continue downwards, the body enlarges rapidly.

The ore is black, coarsely crystalline, and except around the periphery of the kidneys, massive and not disseminated. It assays from 39-42 percent chromic oxide.

From the road at the river one mile west of the deposit, it is only 7½ miles by second-class road to the paved Redwood Highway, at a point which is 10 miles from Crescent City and 76 miles from Grants Pass, Oregon.

Camp 7 Group (7)

Prospect: This prospect is located 200 yards north of road to Camp 7 deposit at a point a quarter of a mile west of Camp 7 in Sec. 7, T. 16 N., R. 3 E., H.

Several very old trenches and pits are found in a gulch in the more or less level "Klamath peneplain" surface. The rock is "buckskin" peridotite porphyry, changing in places to a gray-weathering serpentine. A band of non-porphyritic aphanitic dunite that strikes east lies just north of the pits. No ore was seen in place, but about 2 tons of large float boulders (up to 2 feet in diameter) of high-grade ore were scattered around.

Cooncan: This prospect is located about 3,000 feet northwest of Camp 7, and 1,000 feet lower in elevation on the crest of a ridge 700 feet above Coon Creek, Sec. 7.

A narrow lens of chromite, from 5 to 10 inches wide, is exposed for 8 feet in a country rock of blue-gray-weathering serpentine. There are heavy float boulders up to 2 feet in diameter extending down to the creek, possibly totalling as much as 10 tons. Apparently one body of ore has broken out and washed down hill. Another may be discovered with further digging. The steep-cliffed climb up to the road, however, makes this prospect uneconomic unless a large body is proved.

Camp 7: This prospect is located half a mile southwest of the camp itself, about 1,000 feet from the end of the road and 400 feet below. Cable tram is used to carry ore from the quarry to the bunkers at the end of the road. The prospect is in the SW¼, Sec. 7, T. 16 N., R. 3 E., H., near the west range line.

The country rock is blue-weathering serpentine, usually non-porphyritic. Occasional bands of diallagite appear, one of which lies just below the quarry. Fine parallel layers of chrysotile one millimeter wide, lying three millimeters apart, make up a band about 5 inches wide. Magnesite lenses up to 6 feet in length by 4 inches in width appear. Pegmatitic-appearing dikes are composed of light-green pyroxene crystals up to several centimeters in diameter. The country rock and chromite lenses are considerably broken up, faulted, and jumbled in blocks, making the outline of the ore very hard to distinguish, especially as the fault surfaces are usually plastered with a thin serpentine layer. The main trend of the ore zone seems to be about N. 15° E., dipping very gently to the east. The quarry is 90 feet long and up to 25 feet deep, although usually less. At one place a narrow ore band was seen to strike north and dip 55° W. Across the 20-foot north face, ore in several bands probably totals 5 feet in width.

A careful average sample taken from the ore piles, which total about 300 tons of mined chromite, assayed only 29.52 percent chromic oxide. It was said that ore from this mine averaged about 48 percent. The piles were well diluted with serpentine which occurs on all the joints and shearing places. Some of the ore appears clean and high-grade. A large part of the ore is made up of disseminated crystals in rock.

A small cut 20 feet northeast of the quarry exposes an orebody consisting of a minimum of 2-foot width of high-grade ore, and 3 feet of low-grade.

Fifty feet to the northwest 18 tons were mined and piled. A 6-inch seam appeared in the face of the cut. One hundred feet southwest of the quarry a 5-ton slab lies on the surface. It is probably float from the main body above.

Camp 7 is located 13 miles by forest road (closed in the winter) from Gasquet, which is about 73 miles by the Redwood Highway to Grants Pass and 17 miles to Crescent City.

Camp 8 (8)

Camp 8 is located near the center of E½ Sec. 19, T. 16 N., R. 3 E., H., Del Norte County. It is 2½ miles by forest road south of Camp 7, and about 15 miles to the Redwood Highway at Gasquet, thence 73 miles to Grants Pass.

The country rock beneath a heavy soil overburden is gray-weathering serpentine with much secondary white pyroxene. Four adit tunnels extend westward into the steep hillside, being spaced at about 40-foot intervals for 150 feet, approximately on the same level, in a N. 35° W. direction. They are now all caved and closed, and little solid rock can be seen. All but 40 tons of the 1,000-ton ore pile had been removed at the time the property was visited. The remaining ore appears to be medium- to high-grade, but has a large amount of serpentine mixed with it and needs careful sorting to maintain a good grade. It is highly sheared, with numerous slickensided surfaces, many of which show green uvarovite and pink kammererite crusts.

Two cuts lie 25 feet beyond the northern tunnel, and expose a dike of what appears in hand specimen to be a white hornblende trachyte. Two cuts 100 feet south of the southern tunnel (and below the road) have yielded 10-12 tons of ore and indicate the extension of the ore zone. Another cut 100 feet further south also shows narrow seams of ore.

Siskiyou County (See Fig. 11)

Youngs Valley Group (9)

Doe Creek is located in the center of the W½ Sec. 32, T. 17 N., R. 5 E., H., Siskiyou County.

Two large kidneys, lying 100 feet apart in a northwest line, protrude from the fairly level surface of the ground 5-8 feet. The northwest kidney has exposed dimensions of 18 feet in two directions with an average height of 6 feet. The southeast kidney is 36 feet long, 11 feet wide, and at least 12 feet deep, as exposed in a pit along the south side. Both kidneys lie in a serpentine bedrock and are rounded in form. They assay 41.56 percent chromic oxide; 14.68 percent iron oxide and 5.11 percent silica. The deposit is mentioned by Maxson (33a, p. 153, fig. 20), and a picture is given.

Mammoth (fig. 14) is located at Cyclone Gap in the S½ Sec. 15, T. 17 N., R. 5 E., H., Siskiyou County.

The deposit consists of one large irregular body which juts out in a 30-foot cliff on the steep north side of a ridge just west of Cyclone Gap. The country rock is massive dunite, altered in part to serpentine.

Considerable development has exposed three sides of the kidney and determined all but one dimension. These dimensions are 25 feet long, 20 feet wide, and at least 60 feet deep (see fig. 14). Although the kidney protrudes for only 25 feet, a cut and shaft on the west side have proved ore the rest of the way, the end not being reached. Several inclusions of country rock in the orebody will somewhat reduce the tonnage.

The ore is characterized by much green and lavender stain (garnet and chlorite). It assays 49.84 percent chromic oxide, 14.83 percent FeO, and 3.67 percent silica. Near the border of the included material chromite appears as small bands and lenses within the dunite (fig. 15), which is also figured by Maxson (33a, p. 151, fig. 19) with a specimen which seems to be broken from the same spot.

White Feather is located in the SE¼ Sec. 4, T. 17 N., R. 5 E., H., Del Norte County.

This deposit lies on the north side (perhaps 100 yards from the top) of the ridge bounding Siskiyou and Del Norte Counties, on a northeast slope.

The country rock is serpentine. The deposit is kidney form, elongated N. 20° W. for at least 30 feet in length, and its average width (although not completely exposed) must be at least 8 feet. The upper (western) surface dips into the hillside 45-80°. At one place where the eastern surface is exposed it dips in the opposite direction, 55° E., suggesting that the deposit may enlarge downwards. The ore assays 37.88 percent chromic oxide, 12.60 percent FeO, and 2.03 percent silica.

North of Seiad (10)

North of Seiad consists of two claims located a quarter of a mile apart in the SE¼ Sec. 7, T. 47 N., R. 11 W., M. D., Siskiyou County, at an elevation of about 5,000 feet, close to the east section line. They lie N. 20° W. about 2 miles from the Seiad Valley Chromite mine.

Blue Eagle Claim is located just west of the main ridge which runs down to the Seiad mine. The country rock is a porphyritic peridotite except within 200 feet of the deposit, where it becomes equigranular and fine-grained, probably changing to dunite.

The orebody strikes N. 10-20° W. and dips 45° E. It outcrops for 20 feet, being 5 inches wide at the top (north), widening to 5 feet or over in the northern 10 feet, and then narrowing to about 2 feet at the southern end. It occurs as a fat lens which pinches out quickly at both ends.

The ore is both disseminated and banded, containing considerable gangue. A chip sample taken across and along the exposed face of the lens assayed 24.56 percent chromic oxide. Small float appears 200 yards to the west.

Black Eagle claim lies a quarter of a mile to the S. 70° W. of the Blue Eagle claim and at about 100 feet lower elevation, near the bottom of a steep gully. Near the deposit peridotite banding due to orientation of diallage crystals is prominent, and strikes N. 45° W., dipping 70° S.

The ore occurs in a narrow dike, varying from a foot to 10 feet in width, and running up and down the hill for 50 to 75 feet, striking N. 55° W. and dipping 70° S., except where it is exposed in a cut at the lower end, and strikes N. 20° W., dipping 50° W.

The banded ore in this cut (and less distinctly elsewhere) consists of alternating layers of high-grade chromite (assaying 54.79 percent chromic oxide), and chromiferous dunite. A section across the entire zone consists of about 30 percent bands of 50 percent chromite, and 70 percent gangue of perhaps 10 percent chromite. Although the boundaries of the bands appear to be sharp, they actually do show some gradation upon close examination, and the gangue material has about 10 percent chromite crystals. The high-grade ore is associated with kammererite, in small interstitial grains and large bundles of plates (up to 15 millimeters in diameter) in cavities. The bands vary in size. Usually they occur in pairs, with a thicker (1- to 3-inch) band above a thin band (¼-½ inch), separated by about ½-¾ inch of gangue. Some of the bands are not continuous throughout the outcrop, but form shorter lenses.

The country rock to the east and below this deposit shows numerous "splatters" and fine dissemination of chromite.

*Seiad Valley (11)**

Seiad Valley is located just north of the forks of Seiad Creek, in Sec. 20, T. 47 N., R. 11 W., M. D., Siskiyou County.

The country rock is a distinctly banded and commonly finely laminated and slightly schistose buff-colored fine-grained non-porphyritic dunite lying in a strip which appears to be about three-quarters of a mile wide at the mine. The schistosity in the rock strikes N. 45° W. parallel to the dunite contacts, and dips generally 50° NE. There are at least two main ore-bearing zones which vary in width from a few inches to 20 to 30 feet, and they extend for over 1,000 feet up the backbone of a steep ridge and across its top, again cropping out on the other (west) side in full width. The ore lies parallel to the lamination and schistosity in the rock (see fig. 16). Within the zones the ore may occur in grains and crystals disseminated throughout the rock, but it more often appears as streaks and bands from a fraction of an inch up to several feet in width. In some cases the chromite grains are so aggregated that the linear element is most prominent (see fig. 17); in other cases the planar elements are predominant (see fig. 18). These bands may be continuous for 25 to 50 feet, but usually give way to other such extremely elongated lenses within a shorter distance. These bands of ore may constitute up to 80 per cent of the total ore-bearing zone, but they more often make up about 50 per cent.

Hamburg (12)

Hamburg consists of two deposits. The southern one which lies on top of a ridge 3½ miles west-northwest of Hamburg Bar, on the south side of the river, near the center of the south edge of the SE¼ Sec. 27, T. 46 N., R. 11 W., M. D., Siskiyou County. The northern deposit lies near the center of Sec. 27.

The southern workings lie at the top of a steep narrow northeast trending ridge, at an elevation of 3,600 feet. The northern workings lie 400 feet below, about 900 feet N. 30 W., on a more gentle slope. (See fig. 19.)

The country rock is predominantly a fresh dark-green dunite, somewhat jointed, and with almost no serpentinization visible, although the olivine is weathered yellow on the surfaces and in some places is secondarily altered. Diallagite appears locally in narrow dikes.

At cut No. 1 (see fig. 19), the lower end of the ore lens varies from 1 to 2 feet in width, strikes N. 30° W., and dips 60° W. Followed upward it appears to split, the eastern branch running to cut No. 2, the western pinching out in another 25 feet. At No. 2 a shallow tunnel intersects the zone at a depth of 15 feet, where the ore is about 4 feet wide, while at the surface it is only 1 foot, with a strike of N. 20° W. To the northeast 150 feet, another parallel zone has been opened. Here two bands strike N. 35° W. and dip 45° S. The total width of the ore within the zone is about 4 feet, and it is exposed for perhaps 50 feet over the crest of the ridge.

This zone apparently continues for 600 feet N. 60° W., the solid outcrops appearing at points numbered 4 to 7. Along this zone a peculiar dunite-chromite breccia appears, composed of rock fragments

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Ed. Note: See also the new publication "Chromite deposits in the Seiad quadrangle, Siskiyou County, California" (Rynearson and Smith 40).

cemented in a matrix of fine disseminated chromite and whitish gangue. At No. 4 the banded ore is at least 2 feet wide; at No. 6, it is 18 inches wide and crops for over 10 feet, striking N. 60° W. and dipping 45° S. The three pits at No. 8 were caved, but a line across the ends of the pits would trend about N. 40° W. The ore bands here are said to have dipped about 45° W.

The ore is of the ''tiger ore'' banded type, occurring in well-defined zones from an inch to several feet in width (see fig. 20). The bands within the zones are remarkably regular and even persistent for as far as 10-15 feet; and they are distinguished by the relative content of chromite disseminated through them, which makes the various individual bands appear darker or lighter. The various bands also break apart freely when struck with a hammer, often into thin sheets, from a quarter of an inch to 2 inches in thickness.

In an ideal case, one zone would appear with the lighter colored (low-grade) bands on the outside, with successively darker bands appearing in pairs on each side toward the center of the zone, and ending with a parallel adjacent pair of nearly pure chromite bands in the center (see fig. 6). This ideal is not reached, but it is sufficiently clearly indicated. Usually one side of a pair is missing, or the later inner band will have cut across the outer, which in places has been contorted by the later intrusions (see figs. 7, 8).

The entire structure is analogous to the ''multiple dike,'' with the added feature in the increased concentration of chromite in each successive intrusion. Analysis showed 47.1 percent chromic oxide, 15.86 percent FeO, and 7.95 percent silica.

Moffat Creek (13)

Moffat Creek consists of two groups; the southern claims in the ''Mineral Range'' of hills lie south and west of Moffat Creek in Secs. 34 and 35, T. 44 N., R. 8 W., M. D.; and the northern claims, lying north of Moffat Creek and east of the highway, mostly in Sec. 26 (see figs. 21, 22).

Southern Claims. The normal country rock for all the deposits in this group is a dark-green serpentine, varying from massive to the more common highly sheared and broken types. Chrysotile and talc zones are common, and in places the rock varies into the relatively unaltered peridotite and massive dunite facies, but these are both definitely subordinate in amount within the area.

Local structural indications are very irregular and the attitude of the orebodies difficult to ascertain, partly on account of the badly caved nature of the openings and partly due to the broken nature of the rock. The attitudes of those orebodies that could be determined were often irregular, but when the 12 occurrences in the whole group were carefully mapped, a surprisingly definite alignment into two coordinate systems appeared. This is shown in fig. 21 by lines connecting the deposits added after the map had been completed. The two directions are N. 18-20° E. and N. 70° W. The ore from the southern deposits is generally rather low in grade. Much of it is badly mixed with serpentine (as at No. 2 and No. 4), and much appears in narrow bands and grades into the disseminated type of ore (as at No. 4 and No. 5). Some assays were made as follows:

No.	Cr_2O_3	FeO	SiO_2
1	53.98	15.52	2.87
2	44.20	17.62	6.98
3	48.51	15.23	6.24
9	53.68	15.86	2.79

Notes on Individual Deposits:

1. Structures in the sheared serpentine in small pits trend northeast, dipping 50° S.E. A small kidney has been removed; only small float remains.

2. Two pits lie in an east-west line. The western orebody apparently raked 45° in an S. 50° W. direction, for 15 feet. Small float, the ore fair in grade but in narrow broken bands, with much serpentine gangue frozen to it. It would probably average less than 35 percent Cr_2O_3 cobbed.

3. Pit entirely dug in soil. It is 10 feet deep and 20 feet long. Ore is in small float pieces, less than 1 inch in diameter.

4. Pit in creek bed; showing ore in narrow irregular stringers, less than 2 inches wide individually, and totalling less than 2 feet within an 8-10 foot zone, which strikes N. 40° W. and dips 35° S. The ore is patchy and much broken. Another small cut lies 75 feet N. 50° E. across the creek.

5. A tunnel (partly caved) runs due south into the hill for about 40 feet, exposing banded ore which strikes north and dips 45° W. Another pit 20 feet farther south lies on the same zone. The bands seem to be up to 10 inches wide, but are not continuous and grade into the disseminated type. There has been much shearing and some displacement of orebodies.

6. Three pits, now completely caved, with no bedrock showing, are aligned N. 40° E. for 70 feet. Float is very small.

7. Cut is 10 feet deep below a massive serpentine ledge, which strikes N. 20° E. and dips 40° W.

8. Two shallow caved cuts with no bedrock showing are aligned N. 5° W. Float is small.

9. Caved tunnel 20 feet long and crosscut 25 feet long. Tunnel is due north, crosscut east at right angles. Country rock is of much-jointed dunite. One small ½-inch stringer of chromite is visible, striking N. 45° W., vertical. The east-west orebody is said to have varied up to 2 feet in width, and to have gone down 12 feet, with the vein still appearing in the floor of the crosscut 1 inch wide at the west and 4 inches wide at the east end. About 15 tons were shipped from here; 4 tons now lie piled.

10. Caved cut, but no bedrock showing. It is said that 400 pounds have been shipped from here.

11. Not visited. Said to have been a small kidney 2 feet wide, from which 2 tons were shipped. Now the remaining ore face is said to be 2 feet long and 8 inches wide.

12. Not visited. Cut said to have exposed a kidney from which 2 tons were shipped. Now the remaining ore face is said to be 2 feet long and 8 inches wide.

About one-half to one pound of the best grade of the small float was taken from each of these cuts (1 to 10) to make up a sample, which assayed 48.55 percent chromic oxide, 16.22 percent FeO, and 6 percent silica.

Northern Claims. The country rock north of Moffat Creek is more massive and less altered than that to the south, and consists predominantly of yellow-weathering diallage peridotite, with only small areas of serpentinization. The orebodies appear to be larger and of higher grade (less broken and mixed with serpentine) and more continuous than in the southern area. A slightly different alignment of orebodies appears upon mapping nine of these deposits, the two directions being N. 40° E. and N. 65° W., with the suggestion that the latter plane dips steeply to the south. (See fig. 22.)

Ore from the northern deposit is much higher grade in appearance in nearly every case, and comes cleanly from the rock face.

Samples assayed were as follows:

	Cr_2O_3	FeO	SiO_2
Average of pits Nos. 1 and 4 to 9	49.66	15.36	5.05
No. 6 (Lutrelle)	47.15	19.15	6.01
Allison (high-grade)	56.31	14.45	0.87

Notes on Individual Deposits:

1. *Allison.* Small cut, with about 2 tons of ore on dump. Caved, but oreface said to be 10-12 inches wide. Ore is fair in appearance.

2. *Allison.* Not visited. Small cut, float.

3. *White and Brown.* Not visited. Two tunnels, both open, from which 4-5 carloads (200-250 tons) have been shipped. A 4-foot face of ore is said to appear in the end of the tunnel.

4. *White.* Two caved cuts, 75 feet apart N. 50° W. About 50 tons said to have been shipped. Only small float is seen.

5. *Lutrelle.* Large opencut in massive slightly serpentinized peridotite. About 75 tons said to have been shipped from here, taken from a kidney which seems to have an easterly trend, a 60° N. dip, and an average width in the face of 1-3 feet.

6. *Lutrelle.* Opencut 100 feet to east of 5, with about 1 ton of float piled. No ore is in face. Orebody lay N. 65° W., vertical.

7. *Lutrelle.* Opencut 200 feet east of 6, from which considerable ore must have been removed from a kidney which lay N. 55° W., dipping 50° S., and at least 20 feet long.

8. *Allison.* A large opencut, completely caved, and no bedrock showing. Small float.

9. *Allison.* Several small ditches and cuts from which about 25 tons of heavy float were taken and shipped. The orebody or bedrock was never reached. Float scattered 200 feet down hill to creek.

Hayes (14)

Hayes is located a quarter of a mile south of the road and 300 feet in elevation above it, in SW¼ Sec. 32, T. 44 N., R. 8 W., M.D., Siskiyou County.

Claim No. 1. An opencut on an east-sloping hillside shows ore irregularly in places, apparently striking N. 40° W., and dipping 80° E., but with strike varying up to N. 55° W. Minor faults striking N. 80° E. offset the ore in several places, the north side eastward. The country rock is a dark-green, dense, and very hard, ringing dunite, which is somewhat serpentinized along the widely-spaced joint planes. Streaks of yellow (iddingsite?) occur irregularly through the fresh rock. The chromite is quite irregular in outline, and hard to distinguish from the surrounding rock. It occurs along the fracture planes in small lenses throughout the fractured rock, and in larger irregular bodies up to 2 or 3 feet in diameter, some of which are banded with altered olivine inclusions.

Claim No. 2 lies 200 yards N. 10° W. of No. 1, at about the same elevation upon the hillside. Here the rock is altered, being yellow, rather finely broken, and easily crumbled.

In places nearby a talc schist occurs. The rock of the entire hillside contains chromite in fine scattered grains and in minute streaks, possibly as much as 1 or 2 percent. A 20-foot tunnel at No. 2 is badly caved. An almost horizontal high-grade chromite stringer 1 inch wide shows in one face for about 2 feet.

The ore at No. 1 is nearly all low grade, composed of chromite crystals lying in a matrix of dark greasy serpentine of much the same color. This matrix often shows a distinct pinkish cast, suggesting kammererite or stichite. One specimen of the ore assayed 42.25 percent chromic oxide, 14.22 percent FeO, and 8.15 percent silica. At No. 2 the ore is slightly better grade, but probably below 45 percent chromic oxide.

Ball (15)

Ball is located near the top of the ridge, from 100 yards to a quarter of a mile northwest of the French Creek road, along the section line a quarter of a mile east of Section corner 9-10, 15-16, T. 41 N., R. 9 W., M.D., Siskiyou County.

The deposits lie in a rather narrow serpentine belt which forms most of the lower hills along the west side of Scott Valley south of Etna. The orebodies were small scattered kidneys, none of the pits from which they were taken during the war being more than 7-8 feet deep or 10-15 feet long. Little or no ore was seen in place in any of the pits; apparently the kidneys were all exhausted. Six small pits were visited, scattered over a distance of a quarter of a mile. A sample taken from the dumps of each assayed 46.13 percent chromic oxide, 19.51 percent FeO, and 6.27 percent silica.

The deposits are close to the road, at a point 3 miles south of Etna, which is about 18 miles by highway from Yreka. They are not connected by any discernible trends or leads.

De Ferra (16)

De Ferra is located 200 feet west of the road in the center of Sec. 36, T. 41 N., R. 9 W., M.D., Siskiyou County.

The deposit occurs in a green, highly sheared serpentine just below (east of) a ledge of relatively unaltered peridotite. The obscure banding of the rock and the 200-foot line of the pit dug during the war strikes N. 10° E.

Fred Williams, ranger at Callahan who worked on this deposit, says that the shaft in the main pit was 30 feet deep, and that the chromite band was 3 inches wide in the bottom when work ceased. The pits are all caved and little is to be seen at present. One other prospect cut lies 300 feet to the southwest of the main cut and has about one ton of badly adulterated ore on the dump. No ore appears in place in any of the cuts.

Williams says that two carloads of ore were shipped from this deposit in 1918, De Ferra says six. Both men say that the ore ran 47-48 percent chromic oxide. One assay of float gave 48.30 percent chromic oxide, 18.79 percent FeO, and 6.02 percent silica.

The deposit lies just above the road, 7 miles south of Etna and 22 miles from Yreka.

Coggins (17)

Coggins is located in Sec. 35, T. 39N., and Sec. 2, T. 38N., R. 4W., M.D., Siskiyou County, half a mile west of the Pacific Highway, at a point about 3 miles south of west of Dunsmuir. The forest road up Little Castle Creek runs below the mine at about 700 feet lower elevation, and crosses back about 100 feet above it.

The Coggins mine lies about three-quarters of a mile from the Castle Crags mine, which is across the creek to the S. 60° W., and about 200 feet higher in elevation. The ore zone on the south side of the creek has a trend of S. 60° W., and extends from the Little Castle Creek road down to the bed of the creek, a vertical distance of 1,000 feet. It has been exposed at a number of places along this trend, and a low-grade body of ore has recently been uncovered only 100 feet above the bottom of the valley.

The Coggins mine lies in the same line as the ore zone across the creek, and this fact, together with the trend of the workings, suggests that it also is a part of the same ore zone, which is thus over a mile in length and varies over 1,000 feet in elevation.

The western workings have been extensively developed in ore said to run from 40-43 percent chromic oxide. The eastern body consists of ore that probably will not average over 25 percent chromic oxide, and has only been developed by means of shallow crosscuts and pits. All of these were badly caved when seen, but the ore appeared in the sides.

From the attitudes showing in the completely caved workings, the strike of the kidneys here seemed to be near N. 30-35° E. The country rock is similar to that found across the creek, varying through a peridotite from dunite to pyroxenite, the latter occurring to the west of the zone. A narrow (3-foot) dike of andesite cuts the peridotite near the top of the central cut.

To the east 200 yards are two zones of low-grade concentrating ore, 10 to 20 feet in width. A vertical banding of the chrome strikes N. 15 E., and the ore is exposed for 40 feet, again outcropping 30 feet farther north. The ore in the western body is massive or nodular, and according to Coggins, "The average grade of the first 1,000 tons of ore shipped . . . was 40 percent chromic oxide, but it had to be hand-picked to maintain the grade." Coggins reports the following analysis of a representative sample:

	Percent
Cr_2O_3	38
MgO	20
Al_2O_3	9
FeO	12
SiO_2	19

A sample of the high-grade ore was assayed and showed 43.56 percent chromic oxide, 14.36 percent FeO, and 9.38 percent silica.

Much of the ore is nodular (see figs. 23, 24) and the small nodules or segregations of chromite crystals average half an inch to three-quarters of an inch in length.

The eastern body reveals ore that is evenly disseminated or slightly banded, which will average less than 25 percent chromic oxide. It is quite soft and friable. Sampling has shown that the ore of the western body will concentrate to over 50 percent chromic oxide, and it is expected that the ore from the eastern body will concentrate the same.

Shasta County (See Fig. 11)

Castle Crag (18)

Castle Crag, also known as the "Little Castle Creek" and "Brown" mine, is located 3 miles south of Dunsmuir, half a mile west of the Pacific Highway, by a forest road to the foot of the hill in Sec. 2, T. 38 N., R. 4 W., M. D., on the Siskiyou-Shasta county line. The main workings are in Shasta County.

The country rock consists of an enstatite peridotite varying in places into an almost pure, medium-grained pyroxenite, and in other areas toward a dunite. All of these are altered here and there to serpentine; and the whole is cut by joints which appear in several more or less complex systems and grade into true faults in one or two places. A more complete study of the deposit was made by Diller (19a, p. 28), in which he states:

> ". . . The orebody on the first mine level is 146 feet long in a direction N. 40° E., and 40 feet wide with a height of 54 feet. On the second mine level 30 feet below, the length increases to nearly 160 feet but decreases by half in width and thickness."

He reported that the ore broke free from the wall rock on the east side and graded into disseminated ore on the west.

The ore-bearing zone, in which the disseminated and high-grade chromite is sporadically found follows a N. 60° E. trend up and down the steep hillside for a distance of 200 feet above and over 800 feet below the main workings. The zone has been mined over a distance of nearly 600 feet, and ore has been found over 200 feet below the lower workings on the same general line near the trail.

The zone probably extends from the top of the ridge on the south side of Little Castle Creek down to the creek, and probably up to the top of the ridge on the north side, at Coggins mine.

Development work in the main zone about 40 feet above Little Castle Creek (and 500 feet lower than the main workings) has exposed a low-grade ore zone averaging 25 feet in width and at least 100 feet long. The body is well defined on both sides by faulted walls which strike N. 50-60° E. and dip 75° S. The ore is of very low grade within this wide zone, probably running only 5-10 percent chromic oxide. Within the zone, however, are broken bodies of high-grade ore, one of which must originally have been 15 feet long and 4 feet wide, but which is now broken and disassociated, with country rock between the fragments (see fig. 25).

> "This deposit yielded the greatest tonnage of any single lens or segregations of chromite yet developed in the United States (except one at Lancaster, Pa., early in the 19th century), the records of the State Mining Bureau showing a production of approximately 15,000 tons to the end of 1916." (Logan, C. A. 18, p. 185)

Since that time the lower pit has been developed and several hundred tons may have been mined here, as well as more from the main workings. Although the main kidney is said to be worked out, it is quite possible that other bodies may be found within the zone. In the central workings there is a face of banded ore at least 2 feet wide which may lead to another large deposit.

During the summer of 1940, the tunnel below the large lens taken out in 1917-18 was extended for about 100 feet. At a point directly below the southern end of the old orebody the tunnel penetrated a new kidney, and latest word from Manley Brown states that they have penetrated 50 feet of solid ore.

No samples were taken, as the grade has been well established.

> "The shipping ore averages 45-48 percent chromic oxide . . . the sand concentrate (from a jig) assayed 38 percent chromic oxide, and the coarse concentrate 43 percent." (Logan, C. A. 18, p. 188)

Several small outcrops of ore (the largest having only 10 inches width and a few feet length) and considerable high-grade float were observed from a quarter to half a mile south and east of the property, down the ridge, and over the other side toward the Sacramento River. Float was observed as far as the highway.

Tehama County.

Elder Creek

Elder Creek mines, also known as Tehama Consolidated, and Noble Electric Steel, are located in Sec. 16, T. 25 N., R. 7 W., M. D., Tehama County, about 30 miles southwest of Red Bluff, toward the headwaters of Elder Creek. The north deposit, which was visited, lies on the north side of the north fork of Elder Creek below the new forest road which goes up the ridge. This property was originally owned by the Tehama Consolidated Chrome mines; during the war the north deposit was worked by the Noble Electric Steel; the deposit across the north fork of Elder Creek to the south was worked by S. W. Hill; and the one a mile further south across the ridge on the middle fork was worked by W. E. Kleinsorge.

The north deposit lies in a north-trending zone, 10 to 40 feet wide, of completely altered and decomposed rock, which is bounded on either side by yellow- to red-weathering ''buckskin'' peridotite porphyry. The zone is a soft, white, almost flaky material probably composed mostly of talc and magnesite and with some serpentine. The ore lying in this zone consists of a 3- to 8-foot band which has an attitude of N. 15° W. and dips 35° E. It consists of disseminated ore, probably running not over 20 percent chromic oxide and averaging 10 percent. High-grade bodies were also mined extensively from this zone. A piece of float assayed 51.52 percent chromic oxide. The ore was mined by opencut until the overburden became too great, and then the high-grade was tapped by tunnel on three levels, the lower being about 200 feet above the creek, the second 30 feet above, and the third another 30 feet higher. All three tunnels parallel the zone and show low-grade ore in their walls. In a low-grade band 200 feet long, averaging 5 feet wide and developed for 100 feet, about 5,000 tons of ore could be developed. Probably much more is present but not proved. A mill consisting of four homemade concentrating tables and a set of rolls was located in the creek.

> "Small crystals of chromite are disseminated throughout a zone of decomposed serpentine which is approximately one-fourth of a mile wide, extending north and south for two miles along a precipitous ridge, that lies at the head of the middle fork of Elder creek, about one mile south of the Hill and Noble Electric Steel Company's deposits. Numerous samples have been taken throughout the zone, and it is reported that the ore will average over the entire surface area 6% chromic oxide. Occasional pockets or kidneys of massive black chromite are encountered in this zone. Several such deposits are being worked as quarries, and from one there was mined in an open cut 100 tons of ore which is reported to assay 45% chromic oxide." (Logan, C. A. 18, p. 207)

On the Hill property "the work is confined to drifting along several narrow high-grade lenses of black chromite, exposed in the old workings. There are no large ore-bodies exposed." (Logan, C. A. 18, p. 206.) Of the Noble Electric Steel property, he states:

> "The deposit, which occurs as a large irregular lens of high grade chromite in the serpentine . . . is being mined by a large open cut, the face of which is some hundred feet across and from 6 to 30 feet in height, exposing an orebody which varied from 3 to 10 feet in width. There is a heavy overburden here, which must be stripped before mining the chrome, otherwise considerable sorting is necessary. Another orebody, known as the No. 1 working, occurs several hundred feet lower down the ridge. It was from here that most of the chromite was mined by the old company, and only a few small stringers are now exposed in the old workings." (Logan, C. A. 18, p. 207)

Glenn County

Red Hill Group

Red Hill group deposits discussed in this report lie in Sec. 25, T. 22 N., R. 7 W., M.D., in Glenn County, on a steeply east-sloping spur descending from Red Hill (elevation 3,500 feet) to the valley level of about 1,200 feet elevation at Millsaps or Chrome. The Black Diamond is at about 3,100 feet elevation, and the Grey Eagle at 2,500 feet, the latter being located across a saddle in the ridge. The country is rugged and steep, with little vegetation other than chaparral.

> "Chrome ore was first mined here . . . during the early nineties, and up to 1894 over 3,000 tons were shipped out. The property then lay idle until . . . 1916. It was worked part of that year and late in the fall all operations ceased." (Logan, C. A. 18, p. 146)

Most of the above productions seem to have been from the Black Diamond. During the war, shipping grade (37 percent chromic oxide plus) to the total of about 15,000 tons, was taken from the whole district, probably about 3,000 to 4,000 tons being from these two claims.

Both the Black Diamond and the Grey Eagle deposits lie in the north-trending band of meta-peridotite and dunite which forms the steep escarpment rising from the low foothills on the west side of the Great Valley, west of Orland and Willows. This band is not over 2 miles wide, bounded on the east by the steeply east-dipping Jurassic Knoxville shales, and on the west by Franciscan sandstone and shales. As with chromite deposits in other locations, the country rock near or within the ore-bearing zone tends to become non-porphyritic while the large diallage crystals of the normal peridotite become apparent a little distance away. The rock is more or less altered and serpentinized locally, especially along planes of movement.

The rock and orebodies are much broken and faulted, offsets of from 1 to 5 feet having been observed occasionally. The jointing texture varies from a few inches up to a few feet in the more massive areas. The joint planes frequently change direction and curve to join one another. Fracturing predominates over jointing.

Black Diamond Claim. The orebody on the northern end of the Black Diamond deposit consists of a set of several associated narrow bands and stringers of 30–40 percent chromic oxide, which, within a zone (bearing N. 10° W., 40° W. dip) about 7 feet in width, totals about 5 feet in thickness of solid ore, over an exposed distance of 35 feet. It grades from a nodular "bean ore" to finely disseminated ore, with some massive high-grade ore (over 40 percent chromic oxide).

The south workings of the Black Diamond lie about 200 feet south over the ridge, and consist of a large quarry 50 by 75 feet, with a 20–30-foot back face. Only traces of 30 percent plus ore remain, although some 5–10 percent disseminated ore is visible. It is said that a new high-grade orebody had just been opened up in the lower face when operations ceased in 1918; but if so, it is now covered by talus. The deposit probably connects with the ore to the north, and may be continuous with a small outcrop in the road 200 feet to the south and 50 feet lower down.

Grey Eagle. The quarries and prospect cuts of the Grey Eagle deposit stretch over the crest of the east-west ridge in a N. 20° E. direction for about 650 feet, the distance between the northernmost and southernmost pits of the zone (Fig. 26). For this distance and for a width of 30–75 feet, chromite ore of 10 to 30 percent chromic oxide is exposed in the three main pits and in numerous cross-cutting trenches. The north pit lies 115 feet below the crest of the ridge and 400 feet north of it. The south pit is 90 feet below and 250 feet south.

Around the Grey Eagle deposit the strike of the jointing in the country rock of peridotite varies from N. 30°– 75° W., with all dips to the northeast. The strike of the flow structure within the peridotite porphyry, which is mainly due to the alignment and orientation of the tabular pyroxene phenocrysts, and is emphasized by differential weathering, also strikes northwesterly but dips are nearly all to the southwest. Attitudes of jointing and flow are plotted in Fig. 27.

Banding in the Grey Eagle orebodies, only visible in a few localities, strikes N. 30°-40° E., and dips 25°-40° NW. The distribution of the ore is not continuous, being interrupted by patches of barren rock, and its trend is not regular nor is the banding, when visible, uniform in attitude.

The type of ore varies in an extremely irregular way, being found as follows:

Evenly disseminated (10-20 percent chromic oxide).
Banded disseminated (bands of slightly differing grade).
Lenticular disseminated.
Blocks and patches of high-grade (30 percent plus).
Banded high-grade (within low-grade or barren rock).
Stringers and streaks of high-grade (within low-grade or barren rock).

Mapping of the deposit (Fig. 26) shows that the ore occurs in at least six separate elongated bodies, which strike N. 40°– 60° E., lying in a zone striking about N. 20° E. The two southern bodies overlap; the three center bodies lie more or less parallel to each other. All seem to dip rather gently (not over 40°) to the west.

CHROMITE DEPOSITS IN THE SIERRA NEVADA

Previous Work

The geology of the areas in the central Sierra Nevada which have produced chromite has been studied, among others, by Lindgren (94, 94a), Turner (97, 98), and Taliaferro.* The chromite deposits within the Sierra Nevada have been reported upon by Harder (10),

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* Unpublished quadrangles, central Sierra Nevada.

Logan (18), and Taliaferro.† Only a few deposits within this area were visited by this author.

Plumas County

Quincy Group

The Quincy group consists of seven claims, located in Sec. 17, T. 23 N., R. 9 E., M.D., lying near the Rock Creek road, 14 miles southwest of Quincy, near the top of the divide. Two other claims were not visited, but lie 1 mile south (Fido) and 1½ miles southwest (King Snake) of the Bear claim.

Bear Claim. The Bear claim lies 150 feet north of the forest road. The work done consists of shallow (1-4 feet deep) cuts 10 to 15 feet long, which expose angular blocks of chromite lying in deep red soil over an area about 10 feet long and 4 feet wide, extending in a northwesterly direction. The ore is variable, but not of high grade, assaying 34.86 percent chromic oxide.

Salt Claim. The Salt claim, lying 100 yards east of the junction of the main road and the forest road, has ore exposed in the road cut, but only a few inches in width. One boulder 2 feet square was rolled out of the road when it was built. Just above the road 25 feet to the southwest, a small amount of work has exposed an orebody which strikes N. 40° W. and dips 80° E., and is at least 14 feet long. It is 2 feet at its greatest width, but averages 1 foot in width. The ore is perhaps 45 percent chromic oxide.

Salt Extension. The Salt Extension lies on the north end of the Salt and connects with the south end of the Spice, followed by the Pepper still farther north. These claims lie on the east slope of Rock Creek valley. Only a small amount of float appears on the Salt Extension and Spice. No work has been done and no ore shows in place.

Pepper. The Pepper lies three-fourths of a mile north of the road junction on the ridge top. Several trenches have been dug, none of them over 5 feet deep, and about 2 tons of ore have been mined and piled. No ore appeared in place when the property was visited. The ore appeared to be of medium grade.

Bald Mountain Claims. The Bald Mountain claims were not visited. Float up to 1 foot in diameter appears in one place, with smaller float in another. A north-south contact of the serpentine with granite parallels the claims from 50 to 100 feet to the west.

Most of the claims seem to lie along two north-trending zones, which only appear upon mapping of the claims, while the individual orebodies trend northwest.

El Dorado County

Pilot Hill

Pilot Hill is located in the S½ Sec. 6, T. 11 N., R. 9 E., M.D., on the east slope of Pilot Hill, 9 miles southeast of Auburn.

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† Taliaferro, N. L., Field report to the committee on geology and mineral resources: State Council of Defense, 1918 (unpublished).

The chromite lies in serpentine, within 100 feet of the contact with a hornblende schist* which bounds it on the east. The contact runs N. 25° W. and cuts just east of Pilot Hill. The schistosity dips 30° W., parallel to the contact. Serpentine is only a couple of hundred yards wide, being bounded on the west by a line of volcanic knobs running N. 25° W., the most prominent of which is Pilot Hill.

The chromite occurs in narrow stringers (the widest seen was 8 inches, in a piece of float) which have been mined from one pit 6 feet deep (possibly originally deeper) and 10 by 12 feet long and wide. Several other small prospect holes and ditches constitute the whole of the workings seen. No ore was seen in place, and the ore on the dump was mostly low-grade. This property is reported by Logan (18, p. 140) to have produced 200 tons of ore.

Pillikin Group†

Pillikin deposits discussed in this report would all lie within half a mile of an imaginary line, extending for about four miles in a northerly direction. They lie at elevations varying from 700 to 1,200 feet above sea level, and are nearly all confined to the west slopes of an interrupted ridge which extends from the north to the south forks of the American River, Secs. 21, 28, and 33, T. 11 N., R. 8 E., M.D., and Sec. 4, T. 10 N., R. 8 E., M.D. The area may best be reached from Folsom, California, over 8 miles of surfaced and 1 or 2 of undeveloped roads.

The area was first worked in the eighties when much high-grade float was shipped and a number of open pits were dug to restricted depths. Probably most of the work done at that time was on the present Pillikin property. Work was renewed in 1915, progressing by means of shafts and pits with windlasses until 1917, when adits cutting the chromiferous zones at lower levels began to be used. The high-grade zones were stoped to depths of as much as 100 feet, and winzes in a few cases were driven to still greater depths.

Perhaps the most important development during the war, however, was the inauguration of the concentration of the large deposits of low-grade ore. A few of the properties utilized ore with a chromic oxide content as low as 5-10 percent, concentrating it to 45 percent or more. The highest-grade ore found on the Pillikin property did not run much over this figure when properly cleaned and sorted by hand.

When the Armistice was signed in 1918 all work ceased, leaving piles of ore on many properties, totalling perhaps 10,000 tons of 35-40 percent chromic oxide ore (Logan, C. A. 18, pp. 137-140). Extensive developments upon numerous deposits were abandoned.

The chromite deposits lie within the Sacramento quadrangle (Lindgren, W. 94a) in a north-trending band of dunite. Other rocks are pyroxenite, serpentine and associated rock of probable late Jurassic age, bounded on the west by granite, and including within it numerous more or less isolated bands and patches of older rock; chlorite and other schists, jaspery cherts, quartzites, limestones, and lavas belonging to the Carboniferous Calaveras formation. The dunite seems to be intruded in places by diorite, and here and there intimately fissured by quartz, calcite, and magnesite veins and stringers. Much of the rock is rather fresh in aspect, serpentinization being the exception rather than the rule, although later movement has formed rather complex systems of faulting and jointing so that it is hard to break a fresh surface. Silicification is often extensive.

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* Amphibolite of Lindgren (94a).

† *Ed. Note:* See also the new publication "Chromite deposits of the Pillikin area, El Dorado County, California" (Wells, Page, and James, 40).

The main ore-bearing zones in the region are in dunite, and seem to vary from north to northwest trend, and to dip more or less steeply to the east and northeast. It is along these lines that the main ore-bodies are found. A second set of wider northeast-trending zones bearing low-grade ore appears to cut across these zones on the Pillikin property, forming a checkerboard pattern (see fig. 9) with the larger deposits often occurring at the intersections.

Throughout these zones, high-grade chromite (45 percent chromic oxide) is found in vein-like bodies in narrow lenses or in blunter kidneys, often much faulted, broken or discontinuous. Chromite is also found in crystals disseminated throughout the rock, either evenly, giving a fly-specked appearance to the yellow surfaces, or in banded aggregates sometimes called ''leopard chrome'' (see fig. 28). These low-grade ores run from 20 percent chromic oxide down, and ores as low as 10 percent have been mined.

Northwest Basin. Pillikin Property, NW¼ Sec. 28, T. 11 N., R. 8 E., M. D.

This area has been extensively developed by adits at two levels, and by numerous pits, stopes and winzes; but considerable low-grade ore and prospects of high-grade remain. There are about 5,000 tons of 20 percent chromic oxide lying on the dumps at present. Assays from these dumps (by Techow, Sacramento) average 21 percent chromic oxide, and vary from 18-29 percent.

The ore seems to occur within three zones, striking N. 30°-35° W. on an average, and dipping from 20°-80° NE. (Fig. 9). Although the high-grade is almost exhausted at the center of the basin, undeveloped ore is found on the north and south walls of the east-west valley, and a considerable tonnage of concentrating ore is available as well.

Southeast Basin. Pillikin Property, center Sec. 28, T. 11 N., R. 8 E., M. D.

This area lies over the ridge half a mile to the southeast, possibly on a continuation of the eastern zones of the northwest basin. Undeveloped prospects lie along the connecting line between them in several places. Considerable high-grade ore has been removed by shafts, but at present only disseminated low-grade ore is available near the surface. Although the ore appears to be of very poor grade, assays from these pits run 12.3 percent chromic oxide. There are several bands of low-grade ore extending for more than 100 feet.

North Central Area. Pillikin Property, NE¼ Sec. 28, T. 11 N., R. 8 E., M. D.

A zone of small high-grade bodies extends in a line slightly east of north for a quarter of a mile from the southeast basin to this area, from which a number of very large kidneys of ore have been taken in the past. Here again the zones have been mined out to a depth of 100 feet or more, and several adits have tapped them from the eastern slopes. The overburden on the summit of the pass by the road is largely chromite, and this and the old dumps should run up to 20 percent chromic oxide.

Steele Property. West side, NE¼ Sec. 33, T. 11 N., R. 8 E., M. D. A chromite-bearing zone, trending N. 20° E., lies just to the east of a chert band, and was traced for a distance of 150 feet to the south of the diggings, which here consist of a 150-foot tunnel. At present only low-grade ore is visible. Another tunnel on the east side of the ridge near the mill-site was not visited.

Gurney (Darrington) Property. E½ Sec. 33, T. 11 N., R. 8 E., M. D.

1. Upper pits. Here a large opencut 100 feet wide by 200 feet long has been opened in the hillside to extract very low-grade "fly-speck" ore in large quantities. The ore still shows in all the exposed walls, and may continue for considerable distances, although 600,000 cubic feet have been removed. This is one of the two largest areas of low-grade ore seen, but it is of extremely low-grade (5-15 percent chromic oxide).

2. Lower workings. A thousand feet downhill to the southwest lies the old Gurney mill site and the lowest of the workings here (200-foot level) is at about the same elevation. The adit at this level and one at the 25-foot level have been driven into the hillside along a northward-striking zone which dips about 75° E. Stoping from the upper adit and open cutting at the surface have probably exhausted most of the ore in the upper portion of the zone, but the ore lying between the two adits has not been thoroughly developed. The ore-bearing zone at the lowest level is about 15 feet wide.

Main Burnett Property. NE¼ Sec. 4, T. 10 N., R. 8. E., M. D. The northward-trending ore-bearing zones on this property have as yet only been developed to a depth of a few feet. Most of the ore taken out should average over 20 percent chromic oxide. The main zone outcrops for a minimum length of 100 feet, being about 6 feet wide. Two other zones to the west have been exposed but their extent cannot now be determined.

Southeastern Railroad Property. E½ Sec. 21, T. 11 N., R. 8 E., M. D.

The development at this locality consists of numerous pits and adits with stopes on at least three levels. The dumps show that work was done along zones carrying intermittent small kidneys of high-grade ore.

Central Railroad Property. E½ Sec. 21, T. 11 N., R. 8 E., M.D. Development here consists mainly of extensive quarrying of extremely low-grade disseminated ore, lying in a wide north-trending zone for over 700 feet along the ridge top. Adits from the west have stoped the ore from lower levels than could be reached from the surface pits. Two hundred feet to the east of the main zone a shaft perhaps 200 feet deep has been driven, following lenses of high-grade ore.

Dobbas Property. SW¼ Sec. 15, T. 11 N., R. 8 E., M.D.

Slides here have covered most of the workings, which were for the most part of the open-pit type. Only low-grade disseminated ore was visible on the dumps. It seems to lie against a diorite intrusion, and a line of several pits indicating a zone can be seen for some distance to the north.

CHROMITE DEPOSITS IN SOUTHERN CALIFORNIA

Previous Work

The chromite-bearing rocks around San Luis Obispo have been mapped by Fairbanks (04) and the chromite deposits in that region were studied by Harder (10) and Logan (18, pp. 167–178). Short progress reports on various mines in the district are scattered through the reports of the California State Division of Mines.

San Luis Obispo County

Over 35 chromite deposits were studied in the area north of San Luis Obispo between September 15 and 19, 1937, and December 16, 1937, and January 11, 1938.

The claims visited in this county are located in two main groups, the northwest and southeast. The northwest group lies entirely within the Santa Barbara National Forest in Secs. 12 and 13, T. 29 S., R. 11 E., M.D. The deposits in this group can all be included in a circle drawn with a diameter of 1½ miles. The southeast group lies in Secs. 28, 29, 32, 33, 34, T. 29 S., R. 12 E., M.D. The deposits in this group can all be included within a circle 2½ miles in diameter. The distance between the centers of these circles is 4¾ miles. (See Fig. 10 for details.)

Northwest Group

As can be seen from the map (Fig. 10), the deposits in this group lie along two or more parallel zones running about N. 45° W. and lying about a quarter of a mile apart. There also seem to be several less distinct trends at right angles to these lines.

A narrow, steep, very rough, and at present washed-out road leads to the deposits from the highway at 850 feet elevation on Morro Creek, a distance of about 2 miles. Another road comes up to the eastern deposits in the group from the southwest, but it is in very poor condition. Neither road could be traveled by car in 1937, although a truck could get through. From the highway it is about 21 miles to the railroad at San Luis Obispo, or 17 miles to the siding at Goldtree.

The country rock near the deposits is a broken and sheared serpentine, which is in places near the surface highly silicified with numerous solution cavities partially filled with botryoidal chalcedony, the latter especially noticeable on the old erosion surface at the Tip Top deposit. The serpentine at the Eucalyptus No. 1 deposit is highly altered, being soft and talcose in part. The general strike of the ore zones appears to be approximately northwest, with a more or less steep northeast dip.

Sweetwater (1). The Sweetwater deposit is the largest of those in the northwest group and varies in elevation from 1,400 to 1,650 feet. Upon preliminary examination the deposit appears to consist of a single wide ore-bearing zone, trending approximately N. 60° W. for over 500 feet and dipping steeply to the north (see Fig. 29). The southeast end of the worked area (main pits) is at an elevation of about 1,600 feet, while the northwest end runs down to 1,400 feet in a ravine where the old mill is located, and is said to extend up the other side, although only a few prospect trenches show here. According to Logan (18, p. 177):

> "On the Sweetwater claims which lie on the northwest slope of the hill at an elevation of 1,600 feet, a series of tunnels have been driven southeast, at different elevations, on a well-defined fissure in the serpentine. At different points along the general strike of this fissure a succession of kidneys of chromite have been developed by this work. These kidneys of ore vary in size, but three well-defined lenses have been opened up which have a length of 60 feet and a width of from 4 to 6 feet. The general strike of the fissure is N. 60° W., with a dip of 60° to the northeast. On top of the ridge there is an open cut 60 feet long which connects with a tunnel of equal length. These workings show two well-defined lenses of ore of good quality. A cross-cut has been driven which cuts the lenses 30 feet lower down. The surface workings on these claims extend for 100 feet along the general strike of the fissure, and about 1000 tons of ore running 45 percent chromic oxide and 8 percent silica have been developed."

More detailed study and mapping show that two structures modify this conception. There are at least four more or less parallel ore bodies spaced from 25 to 50 feet apart. The orebodies strike N. 42° W. and dip 40°–70° NE., and the apparent strike of the zone as a whole (N. 60° W.) is due to the fact that the bodies lie en echelon, being offset at least three and probably more times at a fairly uniform interval of about every 50 feet along the zone. The amount of offset varies from 10 to 20 feet, the northwest end of each body in every case being northeast (above) the southeast end of the next body. No cross-faulting which might account for this could be seen in the excellent exposures.

Previous mining operations have consisted, as in most chromite deposits made up of varying grades of ore, of high-grading the deposit by following the richer bands and kidneys and cobbing off the poorer.

In cut A (fig. 29) the ore zone is about 16 feet wide, but the varying types of ore are irregular and discontinuous. However, if an average is taken, approximately 8 feet of the band is estimated to be of 5-20 percent grade; 6 feet of 20-35 percent; and 2 feet of 35 percent plus (average 45 percent) ore. This latter is now almost completely mined out and represents the shipping ore mentioned by Logan.

No bodies of this high-grade ore wider than 4 feet were seen at this deposit or elsewhere, and all tend to lens out rapidly and be discontinuous. Probably the 60-foot lens-length mentioned by Logan is exceptional.

Nine samples from the opencuts assayed from 12-23% chromic oxide. When they were gravity concentrated they assayed 48-50% chromic oxide. Minerals associated with the ore are antigorite, picotite, and spinel.

Eureka (2). The Eureka claim lies across the gulch to the northwest of the Sweetwater claim. The only workings to be seen were two long crosscut trenches and one opencut, neither of which exposes ore, although the sheared character of the rock suggests that the continuation of the Sweetwater zone crosses somewhere nearby. It is possible that the continuation of the Sweetwater orebodies may be found at depth on this claim. One small high-grade lens has been uncovered near the creek bottom above the mill.

Eagle (3). The Eagle claim is on the southeastern extension of the Sweetwater zone, and its openings lie upon the point of the ridge about 600 feet away from the main opencuts of the Sweetwater across the gulch.

The workings consist of a small upper pit from which a narrow high-grade body of ore has been removed, and a tunnel driven in to tap this body 30 feet lower. Walter Pierce says that considerable high-grade ore was taken from this claim, and that the orebody was not exhausted when work ceased.

Moonbeam No. 1 (4). Moonbeam No. 1 has several ditches and opencuts, which are located on the lower edge of the flat to the southeast of and below the Eagle claim. A few small orebodies of high-grade seem to have been removed, but none remains in sight. Two cuts in sheared serpentine lie 400 feet north above the flat, and a few pieces of high-grade show that a stringer has been removed here.

Tip Top (5). Tip Top deposit lies at 1,650 feet on the flat-topped spur extending northwestward from the peak. It is about 2,200 feet N. 41° W. of the Eucalyptus No. 1, possibly on the same zone.

The workings consist of an opencut 75 feet long in a N. 41° W. direction, 10 to 30 feet wide and 15 feet deep. At the southeast end a crosscut tunnel at 25 foot depth and opencuts for 50 feet farther to the southeast both lie in the same zone, which appears to dip to the northeast about 50°. Where now visible the ore is only 2 feet in width and consists of disseminated ore which probably will not average over 30 percent. However, the amount of removed material shows that in places it must have been wider.

Chromic Acid No. 1 (6). Chromic Acid No. 1 is down the ridge 800 feet north of the Tip Top claim; a series of opencuts and tunnels in the steep side and across the top of the north-sloping ridge expose an ore zone about 4 feet wide, trending N. 40° W. for at least 150 feet, which seems to dip 60° S. The zone is composed of highly sheared and soft crumbly serpentine. The ore is in disseminated bands (less than 10 percent); irregular long lenses slightly higher in grade (10-20 percent); and small bodies of over 25 percent chromic oxide ore.

Chromic Acid No. 2 (7). Chromic Acid No. 2 consists of a line of shallow and completely caved opencuts occurring to the east of and above the road at a point a quarter of a mile east of the Tip Top claim. Small bodies of high-grade ore were mined here and shipped, but they were too narrow to be followed to depth.

Eucalyptus No. 1 (8). Eucalyptus No. 1 is a deposit lying at 1,750 feet elevation near the base of the steep slope rising to 2,617 feet in Cerro Alto, half a mile to the east. A vertical fault plane, striking N. 30° E. is reached by at least three adits from the southeast. Short drifts along this plane are either in a zone of magnesite and talcose material which seems to parallel it on the southeast, or in the ore which apparently lies beyond the fault on the northwest. The center adit shows a zone of good grade ore (30-45 percent chromic oxide) from 1-4 feet thick, but little or none appears in the other openings. The small bodies of high-grade lie in a matrix of disseminated ore that may be several feet wide. Most of the 400 tons piled on the dump here should only run 15-20 percent.

Eucalyptus No. 2 (9). Eucalyptus No. 2 lies about 1,000 feet southeast of No. 1. A pit 50 feet long and 10 feet deep extends N. 45° W. in highly sheared serpentine. One short drift was dug to the southeast, and a 20-foot incline extends downward to the southwest. All the ore to be seen was of very low grade, and occurred in irregular patches on the walls of the cut. Some high-grade had been mined, as fragments were left on the dumps where the cobbing was done.

Starlight (10). Starlight consists of several ditches, shallow cuts, and one caved tunnel, located on the steep hillside near the top of the ridge 800 feet northwest of Sunrise No. 1, and 1,000 feet southeast of Eucalyptus No. 2. No ore could be seen in place. A few pieces of high-grade float were on the dump.

Sunrise No. 1 (11). Sunrise No. 1 is located 1,000 feet southeast of the Eucalyptus No. 2. A large opencut extending 150 feet in a N. 45° W. direction has a 30-foot face in broken and altered serpentine. Ore now occurs only in one or two small irregular stringers of high-grade. The amount of small broken fragments of ore on the dumps and the size of the cut indicate that a considerable amount of shipping ore was cobbed off, cleaned and shipped from this deposit. At least one short tunnel has been driven into the face of the cut along a narrow stringer. Several ditches in the floor of the cut have not disclosed ore. Another small cut 100 feet to the north is of a similar nature.

Sunrise No. 2 (12). Sunrise No. 2 is about 400 feet downhill to the south of No. 1. Several large irregular pits have been dug and cleaned out with a bulldozer. In a few places small patches of ore are to be seen frozen to the jointed serpentine rock. No distinct orebody or zone appears. At a cut 200 feet to the northeast, about 100 pounds of milling ore are piled in front of a 20-foot cut. No ore was to be seen in place.

Sunrise No. 3 (13). Sunrise No. 3 is located 1,000 feet southwest of Sunrise No. 2 and 2,000 feet west of the Norcross. The rock in which the deposit lies is a sheared serpentine, which along the ore-bearing zone is more or less completely altered and crushed, with numerous stringers of calcite and open vugs of aragonite. Small rounded bodies of a basaltic nature also are found in the zone. An opencut 50 feet wide and 200 feet long was glory-holed from the south through a 100-foot tunnel at a depth of about 100 feet. The walls of the pit show a large amount of low-grade ore, which seems to lie in irregular discontinuous lenses or bands up to 10 feet thick. They seem to strike N. 20° E. and may dip as much as 25° E. The ore in these bodies may run 15 per cent chromic oxide, and then the entire zone, which on the surface appears to be over 100 feet wide, shows some disseminated chromite crystals. Only a few very narrow stringers of high-grade ore were seen. Near the southern edge of the cut a body of diabasic rock appears in the footwall. This type of rock also occurs at a point 150 feet to the east. The hanging wall is soft, highly sheared and altered, with areas made up of talc and tremolite. Small (2-4mm) patches of soft black chromite dust give it a spotted appearance.

The dumps are quite large and part of them may run over 10 percent chromic oxide. The underground work has been extensive.

Captain (14). Captain is located about 1,000 feet northwest of the Brooklyn (West Norcross) claim. The *Northwest openings* are located on the south side of the ridge, and expose a narrow band of low- and high-grade ore for 20 feet in a N. 45° E. direction, dipping 45° NW. Another opening lies 200 feet northwest near the top of the ridge, and exposes a low-grade spotted ore in small irregular patches. The *Southeast openings* (also known as ''Rosie'' claim) consists of an east-west pit 50 feet long and from 10 to 20 feet deep and wide, showing a very small amount of milling ore. High-grade float indicated that some small bodies were removed.

Colonel (15). Colonel is located 600 feet S. 78° W. of the Sunrise No. 3 claim, at the top of the ridge to the west and only a few hundred feet north of the Captain. The main cut exposes ore in more or less isolated small (4-6 inches wide and 1-3 feet long) bodies of medium grade in a dark-green blocky serpentine, containing irregular patches of green pyroxene. There is local brecciation and recementation near the ore. A large body of diabase occurs 20 feet to the south of the main cut. The orebodies seem to strike N. 30° W. and dip 55° N.

About four tons of 40 percent chromic oxide ore have been mined from the cut of 2,000 cubic feet, and further work can be expected to be just as productive.

About 300 feet due north over the ridge and about 75 feet lower, a caved tunnel goes in on the zone alongside diabase. No ore can be seen.

West Norcross (16). West Norcross, also known as the Brooklyn claim, is in the bed of a small creek 700 feet west of the Norcross pit and 1,000 feet south of Sunrise No. 3. A series of large pits extending N. 45° W. for over 80 feet expose an orebody 8 feet or more wide which dips 25-30° N.

The ore is of milling grade, perhaps averaging 15 percent chromic oxide. A rounded body of diabasic rock is included in the serpentine at the west end of the cuts, but age relationship was not clear.

The deposit is located on the north side of San Bernardo Creek valley, only 200 feet above the valley bottom. Large springs flow out immediately below and to the west of the deposit.

Norcross (17). Norcross is an open cut over 200 feet across and 50 feet deep. It has apparently been successively mined from at least three different levels, the last by means of tunnels and glory-holes. During the war the small high-grade bodies were sorted out on platforms and the low-grade milled, giving a concentrate reported to be 44 percent chromic oxide. At the present time the tunnels are all covered or caved, and only irregular patches of low-grade milling ore can be seen in the exposures.

Other Claims. The *Beryl Gem* adjoins the Sweetwater on the northeast.

On the southwest side of the ridge next west of the one on which the Captain and Colonel occur, there is an opencut with a small amount of ore on the dump, and a 100-foot tunnel coming in 50 feet below it. No ore was seen in place.

The *Kingpin* claim lies between the Eureka on the southwest and the Tip Top on the northeast. A few small cuts show very narrow stringers of high-grade ore.

The *Old Town* claim runs southwest from the center of the Sweetwater, down the creek for 1,600 feet. A cut in the northwest side of the creek about 300 feet below the mill exposed a body of high-grade ore of several tons. Walter Pierce says that there still remains a face of the ore in the back of the caved opening.

The *Moonbeam No. 2 and No. 3* claims could not be located. Probably they lie parallel to and southwest of the Moonbeam No. 1. This area was prospected and a few small pieces of float found, but no workings were seen.

The *Dictator* claim lies parallel to and southwest of the Captain, down the ridge.

The *Rosie* claim lies west of the Norcross and Brooklyn.

Southeast Group

Trends similar to those in the Northwest group also occur here. They have a general strike of N. 60°–70° W., rather than N. 45° W. as in the Northwest group.

Castro and Castro Extension (20). Castro and Castro Extension are the farthest northwest of the Southeast group, lying near the middle of Sec. 29. The dividing line between the two claims passes across the orebody.

The country rock consists of altered and broken serpentine, with not infrequent pyroxene and magnesite veinlets. The main orebody is at least 200 feet long in an east-west direction, and is exposed almost continuously for that distance, varying in width from 5 to 25 feet, and possibly averaging 8 feet (see fig. 30). From internal structures, the body appears to strike N. 50°–60° W., and to dip gently to the south. There are several smaller bodies lying a few feet below and to the north of the main one. The main orebody extends over onto the Castro Extension claim for 30 feet, and at the west end another parallel body appears 10 feet to the south and may continue for 50 feet or more.

During the war a large body 300 feet to the east was developed and mined by a 200-foot tunnel and glory-hole. At the present time an orebody 25 feet long and not over 3 feet wide crops in the south face of the glory-hole cut, striking N. 70° E., and dipping 25° S.

Another cut by the road to the north of the glory-hole shows some milling ore next to a diabase inclusion. Near the top of the ridge 200 feet farther east of the glory-hole, a cut 75 feet long shows

ILLUSTRATIONS FOR REPORT

By JOHN ELIOT ALLEN

GEOLOGICAL INVESTIGATION OF THE CHROMITE DEPOSITS OF CALIFORNIA

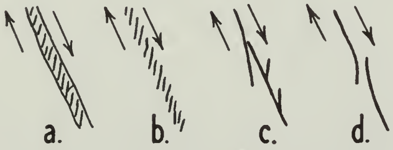


FIG. 1. Types of surface cracks associated with the horizontal fault slip which caused the California earthquake of April 18, 1906. Arrows show directions of movement of underlying crust blocks. (*After* Gilbert 28, p. 13.)

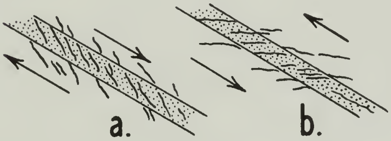
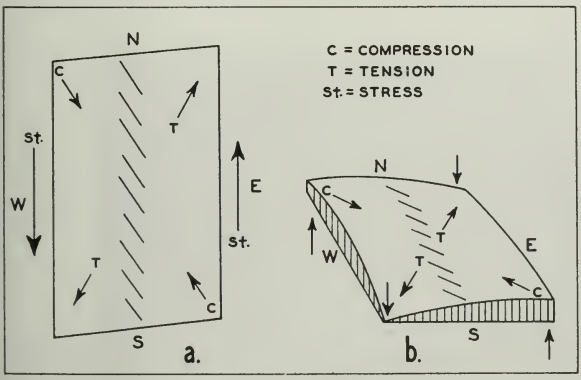


FIG. 2. Ideal section of faults and of subsidiary slicken-sided partings, to illustrate the relations of the attitude of the partings to normal faults (a) and reverse faults (b). (*After* Gilbert 28, p. 13.)



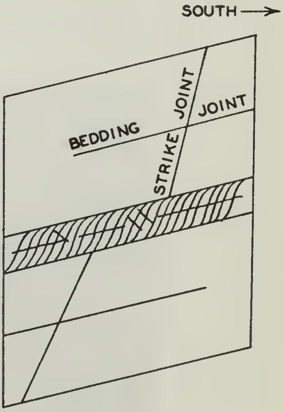


FIG. 3. FIG. 4.

Figure 3: (a) Plan of stress-strain relations caused by slipping along a north-south buried line of weakness. (*After* Nevin 36, p. 114.) (b) Block diagram of the surface stress-strain relations over a steepened area trending north-south. Torsional stresses are caused by a depression of the northeast-southwest areas relative to the northwest-southeast. (*After* Nevin 36, p. 114.) Figure 4: ". . . vertical section, normal to the strike, showing fracture cleavage in shaly beds and joints in massive quartzite beds above and below. Short, open gashes or tension joints may be seen crossing the compression joints in the softer layers." (*After* Leith 23, p. 154.)

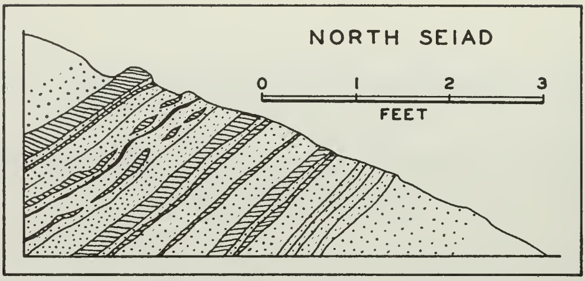


FIG. 5. Cross-section of orebody, Black Eagle claim north of Seiad.

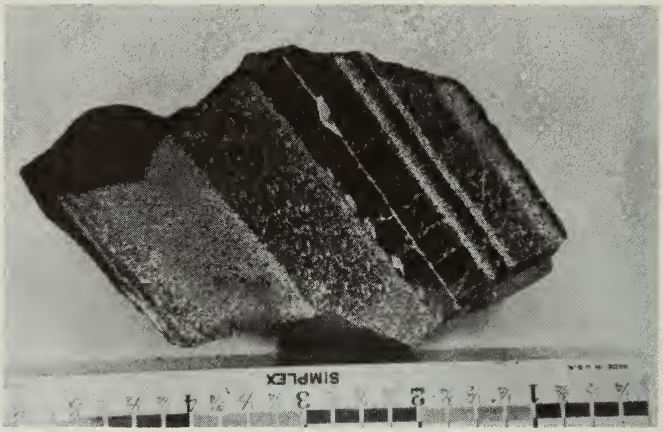


FIG. 6. Banded ore from Hamburg. Parallel paired bands become successively higher grade toward the center.

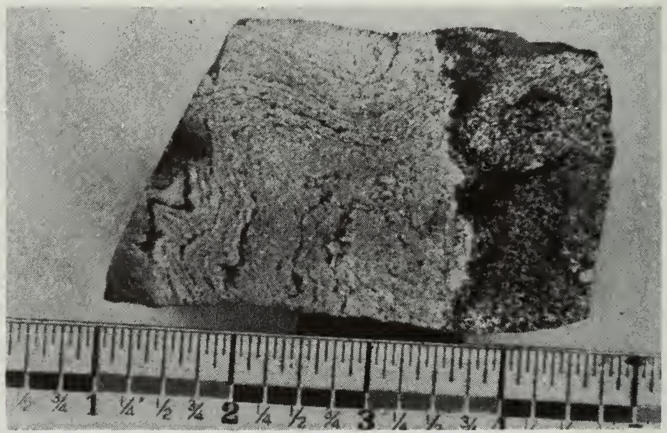


FIG. 7. Ore from Hamburg, end view. The low-grade banded ore is transected and contorted by intrusion of later higher grade ore.

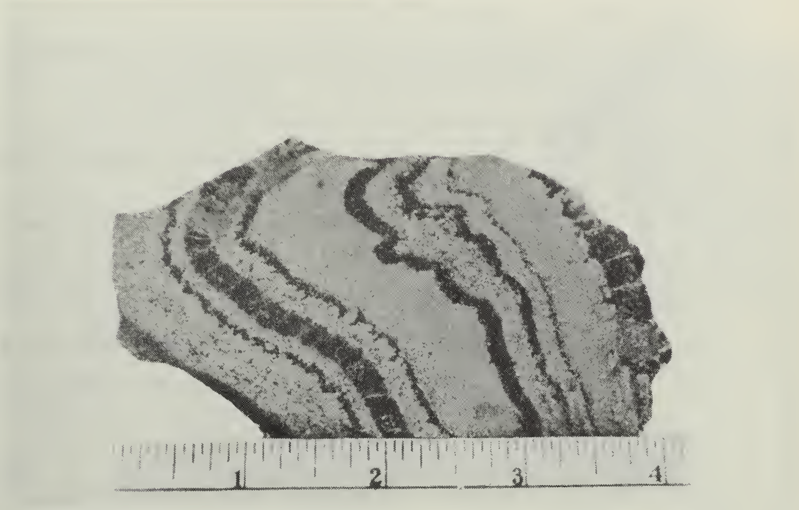


FIG. 8. Banded contorted ore from Hamburg.

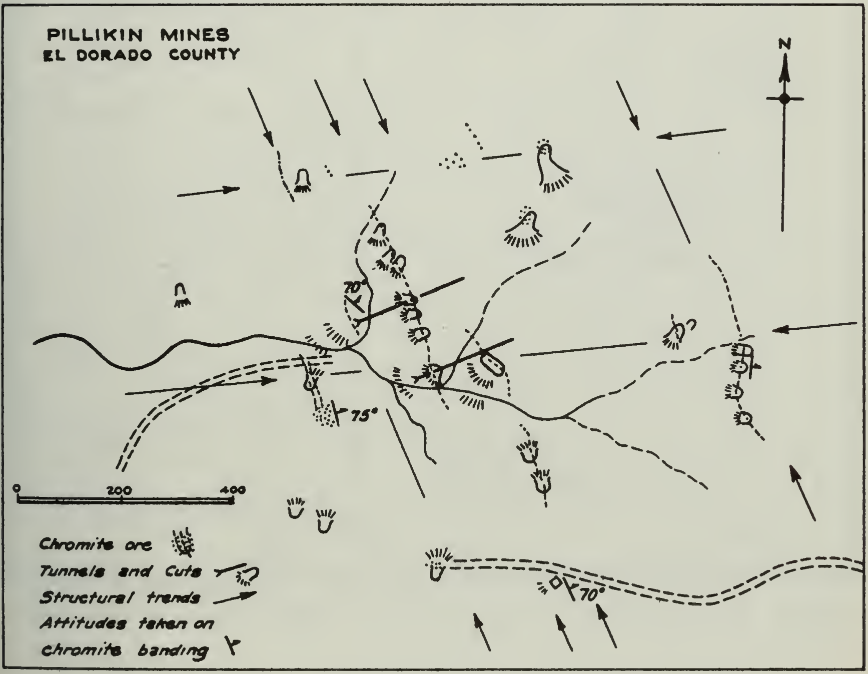
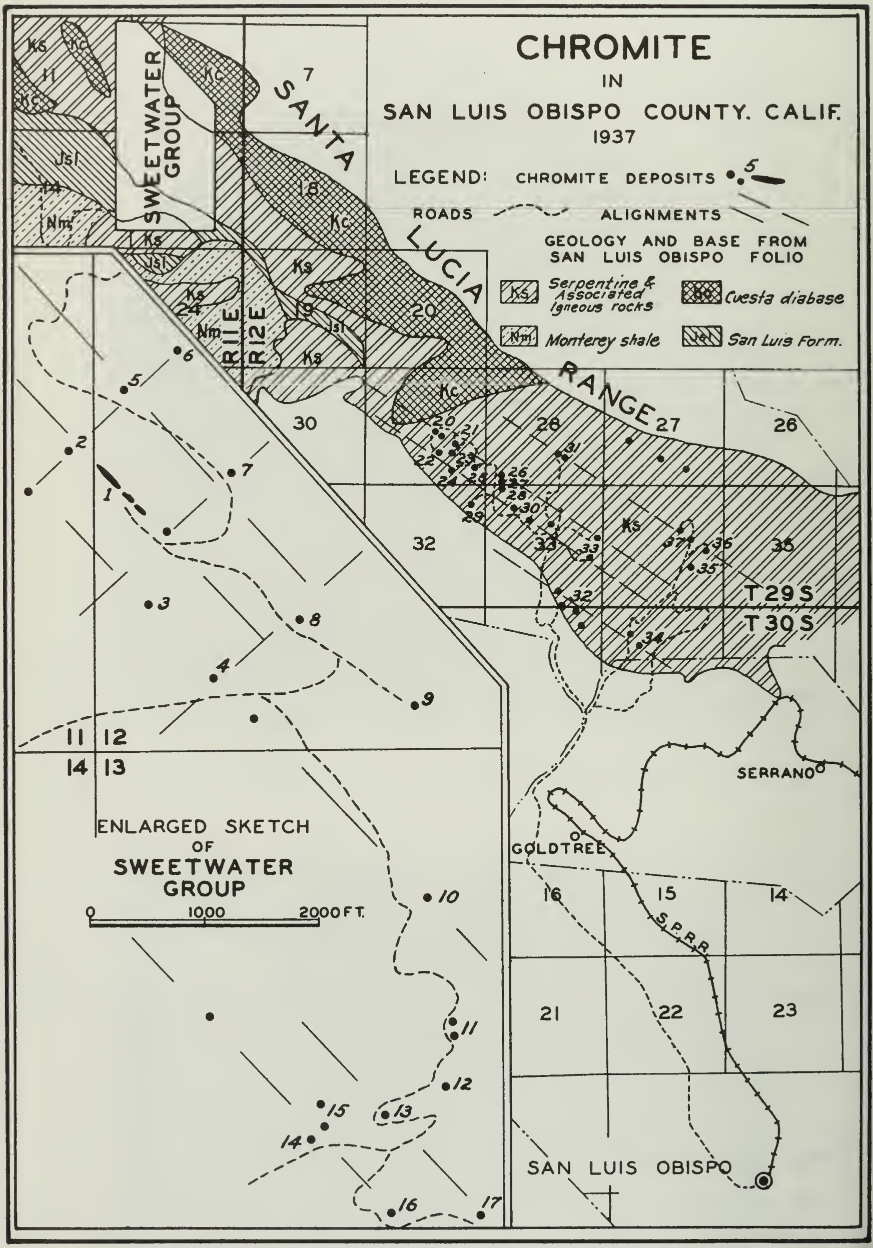

PILLIKIN MINES
EL DORADO COUNTY
N
70°
75°
70°
0
200
400
Chromite ore
Tunnels and Cuts
Structural trends
Attitudes taken on chromite banding

FIG. 9. Structural trends, Pillikin mines, El Dorado County.


CHROMITE
IN
SAN LUIS OBISPO COUNTY. CALIF.
1937
LEGEND: CHROMITE DEPOSITS
ROADS
ALIGNMENTS
GEOLOGY AND BASE FROM SAN LUIS OBISPO FOLIO
Ks Serpentine & Associated Igneous rocks
Kc Cuesta diabase
Nm Monterey shale
Jsl San Luis Form.
SANTA LUCIA RANGE
SWEETWATER GROUP
R11E
R12E
T29S
T30S
Ks
Kc
Jsl
Nm
7
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SERRANO
GOLDTREE
S.P.R.R.
SAN LUIS OBISPO
ENLARGED SKETCH OF SWEETWATER GROUP
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2000 FT.
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FIG. 10. Map of chromite deposits of San Luis Obispo County including Sweetwater group.

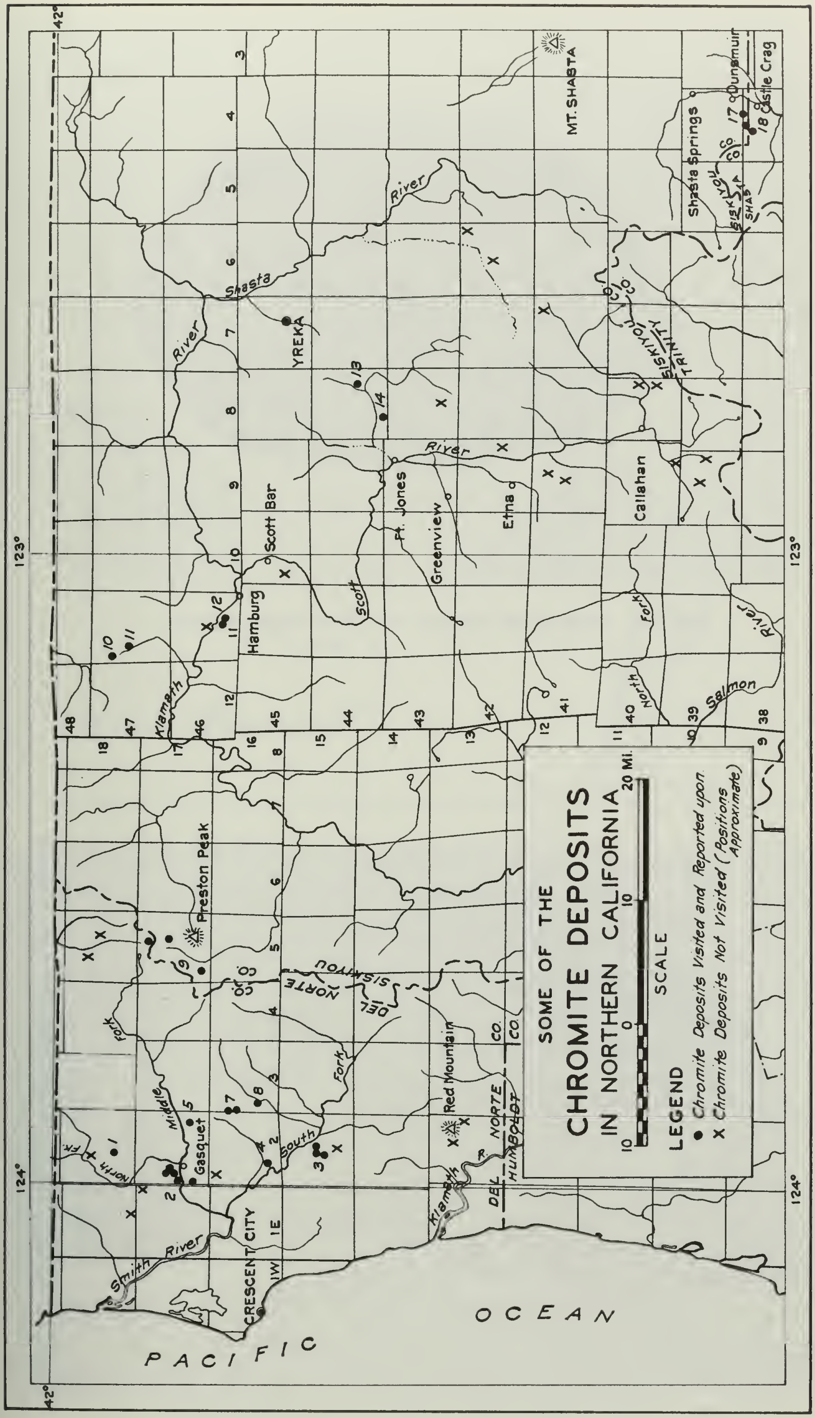
SOME OF THE
CHROMITE DEPOSITS
IN NORTHERN CALIFORNIA
10
0
10
20 MI.
SCALE
LEGEND
● Chromite Deposits Visited and Reported upon
X Chromite Deposits Not Visited (Positions Approximate)
PACIFIC
OCEAN
CRESCENT CITY
Smith River
North Fk.
Middle Fork
South Fork
Gasquet
Preston Peak
Red Mountain
Klamath R.
DEL NORTE CO.
HUMBOLDT CO.
DEL NORTE CO.
SISKIYOU CO.
Klamath River
Hamburg
Scott Bar
Scott River
Ft. Jones
Greenview
Etna
YREKA
Shasta River
MT. SHASTA
Callahan
North Fork
Salmon River
SISKIYOU CO.
TRINITY CO.
SISKIYOU CO.
SHASTA CO.
Shasta Springs
Dunsmuir
Castle Crag
1
2
3
4
5
6
7
8
9
10
11
12
13
14
17
18
42°
123°
124°

FIG. 11. Map showing location of some of the chromite deposits of northern California.

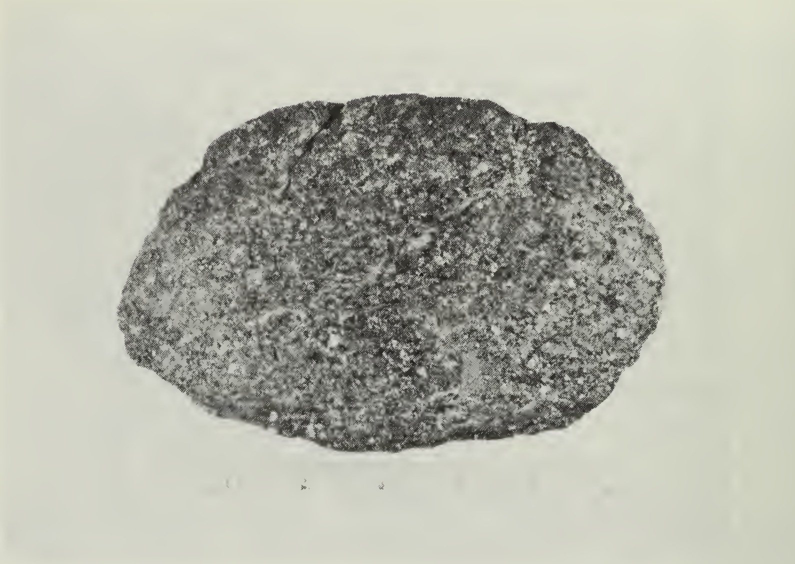

FIG. 12. High-grade chrome ore from High Plateau.

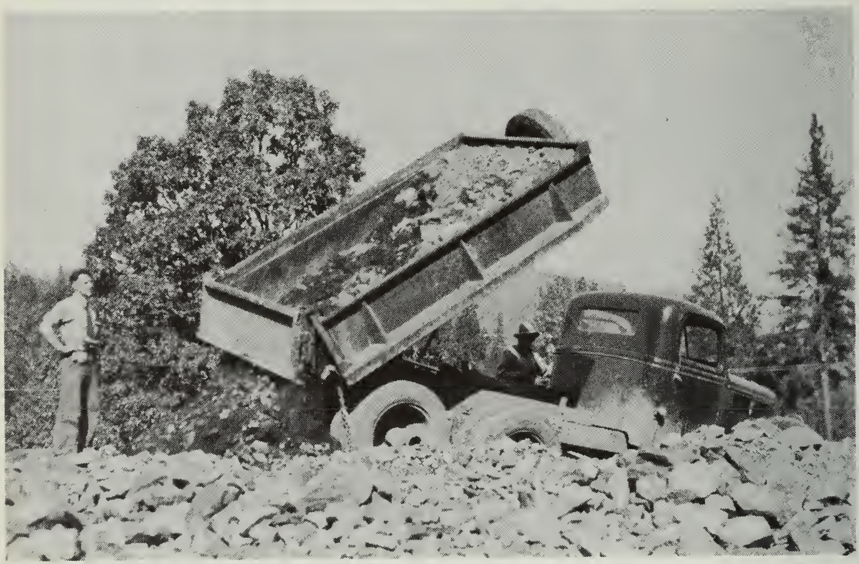

FIG. 13. Loading High Plateau ore at railroad at Wilderville.

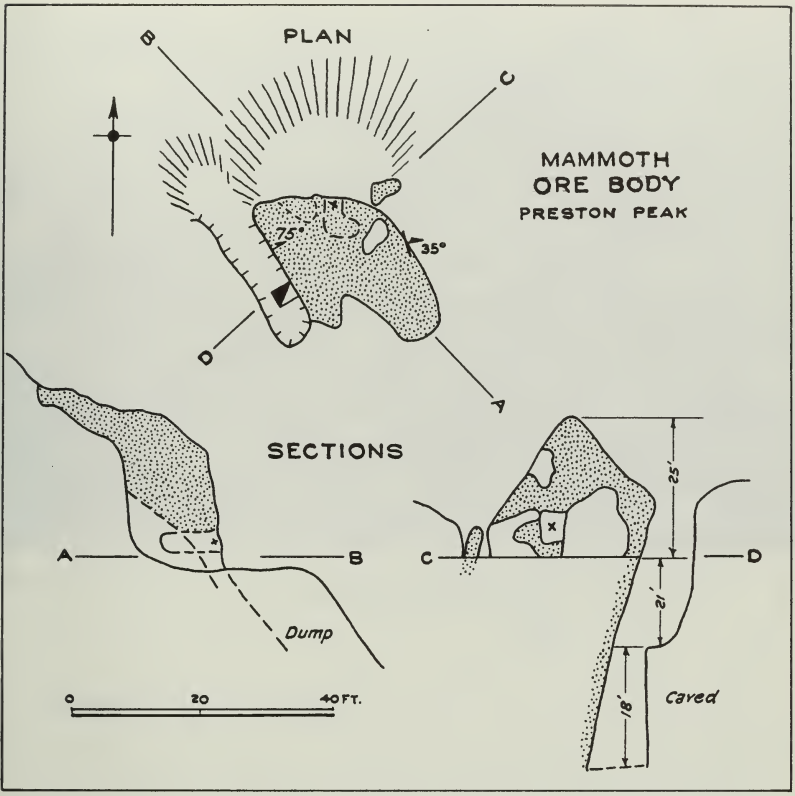
PLAN
MAMMOTH
ORE BODY
PRESTON PEAK
75°
35°
B
C
D
A
SECTIONS
A
B
Dump
C
D
25'
21'
18'
Caved
0
20
40 FT.

FIG. 14. Plan and sections of Mammoth orebody, Preston Peak. For mark X, see figure 15.

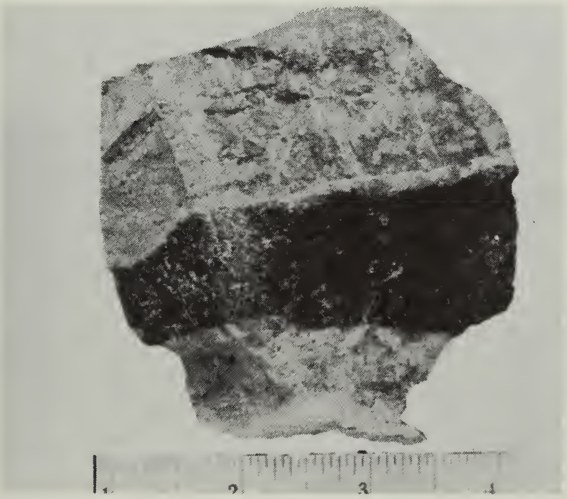

FIG. 15. Banded and disseminated ore from Mammoth orebody. For location of specimen see X, figure 14.

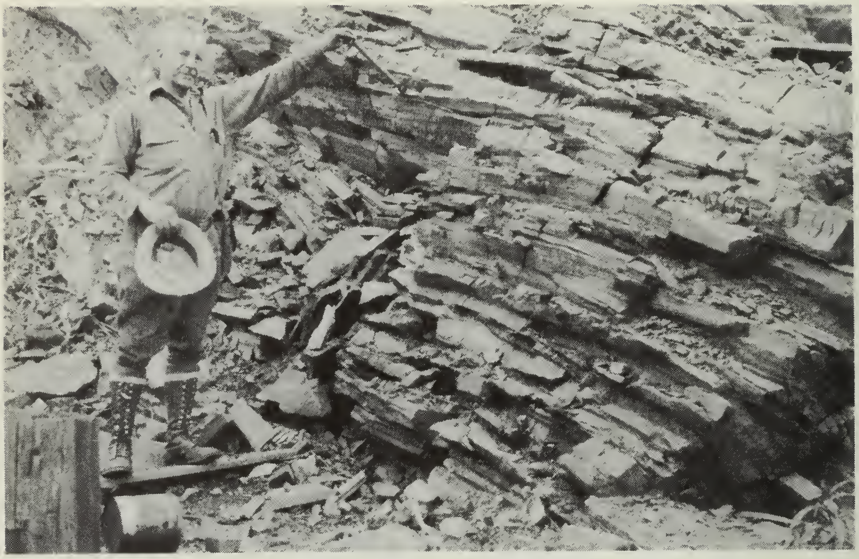

FIG. 16. Seiad ore, banded, in schistose dunite. Attitude of schistosity and bands indicated by hammer.

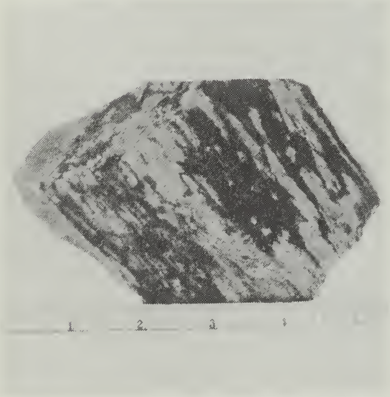

FIG. 17. Seiad ore, showing linear elements.

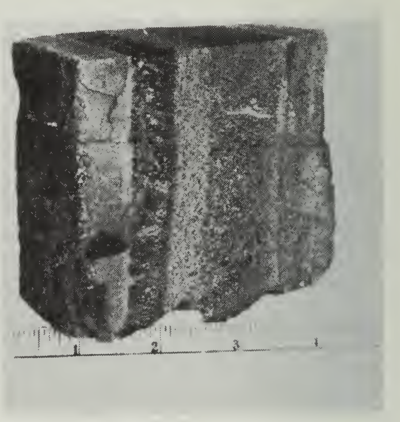

FIG. 18. Seiad ore showing planar (banded) elements.

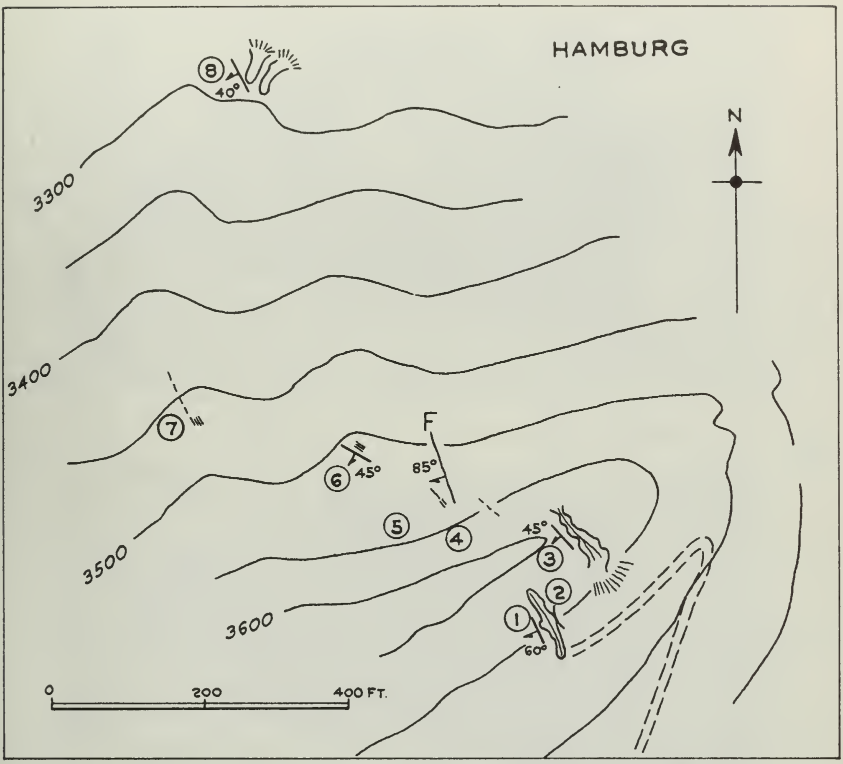
HAMBURG
N
3300
3400
3500
3600
F
85°
45°
40°
60°
①
②
③
④
⑤
⑥
⑦
⑧
0
200
400 FT.

Fig. 19. Hamburg property, showing location of cuts.

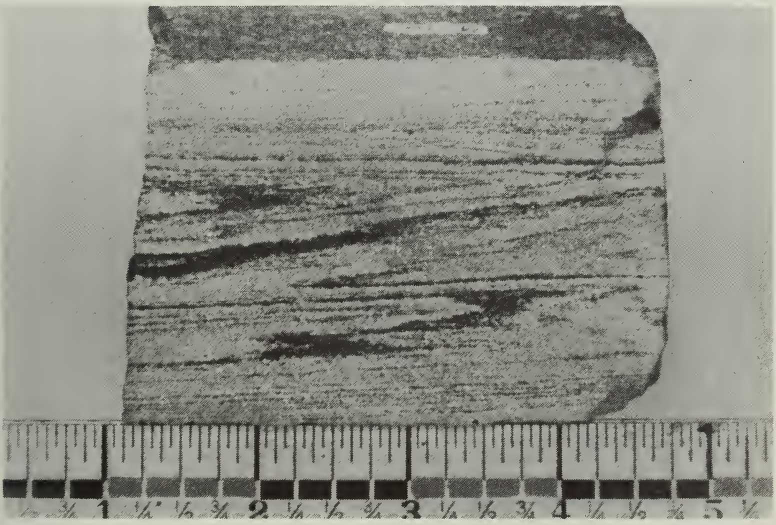

Fig. 20. Hamburg ore, side view of specimen shown in figure 7.

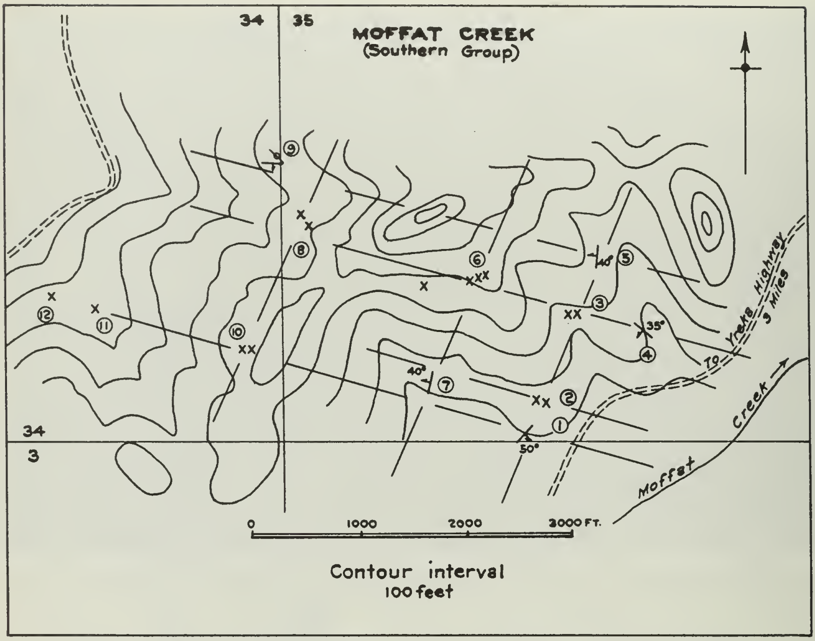
MOFFAT CREEK
(Southern Group)
34
35
34
3
Contour interval
100 feet
0
1000
2000
3000 FT.
To Yreka Highway
3 Miles
Moffat Creek
40°
35°
50°
40°

FIG. 21. Map showing Moffat Creek properties, southern group.

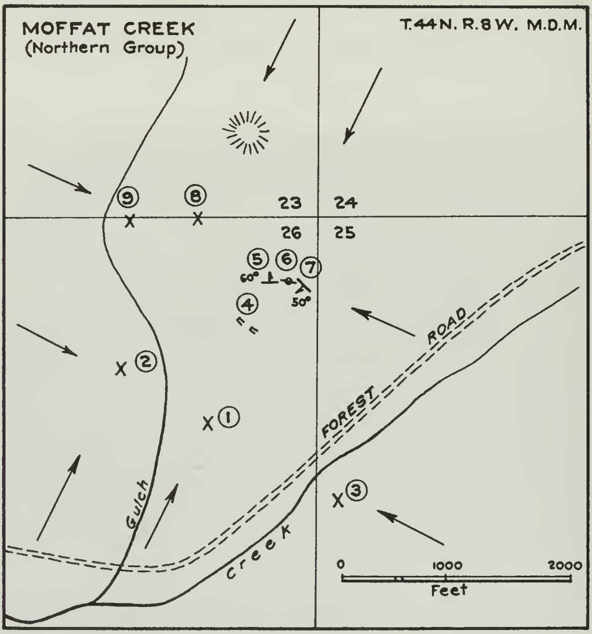
MOFFAT CREEK
(Northern Group)
T.44N. R.8W. M.D.M.
23
24
26
25
60°
50°
Gulch
FOREST ROAD
Creek
0
1000
2000
Feet

FIG. 22. Map showing Moffat Creek properties, northern group.

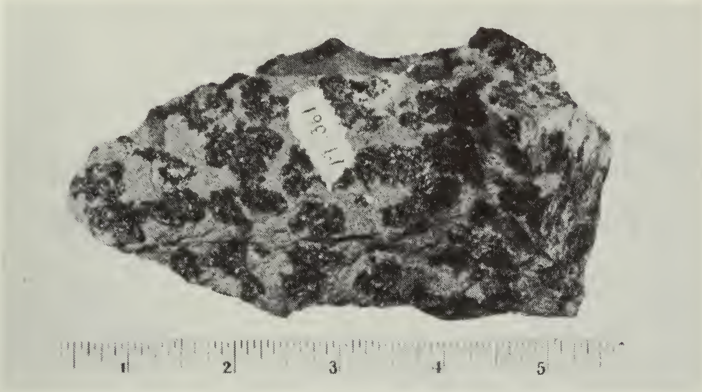

FIG. 23. Nodular chrome ore from Coggins property.

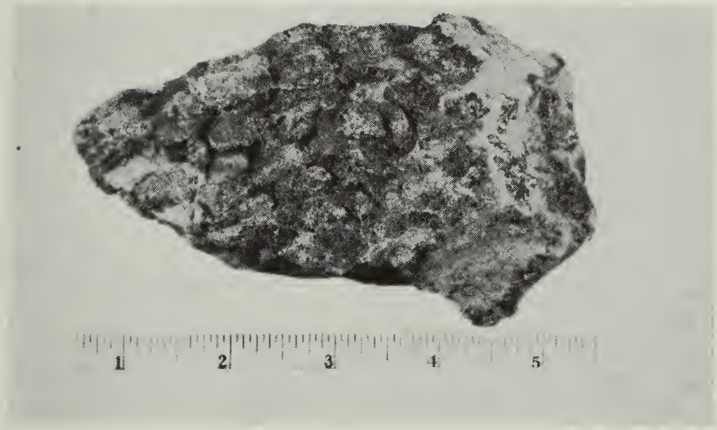

FIG. 24. Same specimen as shown in figure 23, with nodules weathered out in relief.

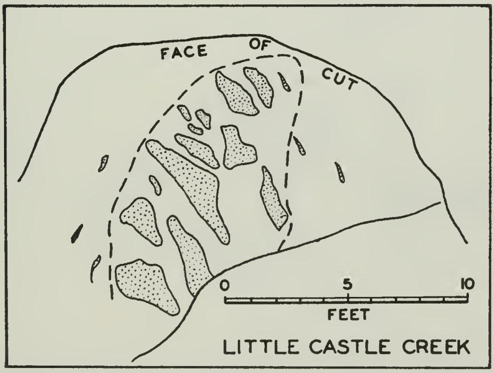
FACE OF CUT
0
5
10
FEET
LITTLE CASTLE CREEK

FIG. 25. Orebodies at Little Castle Creek.

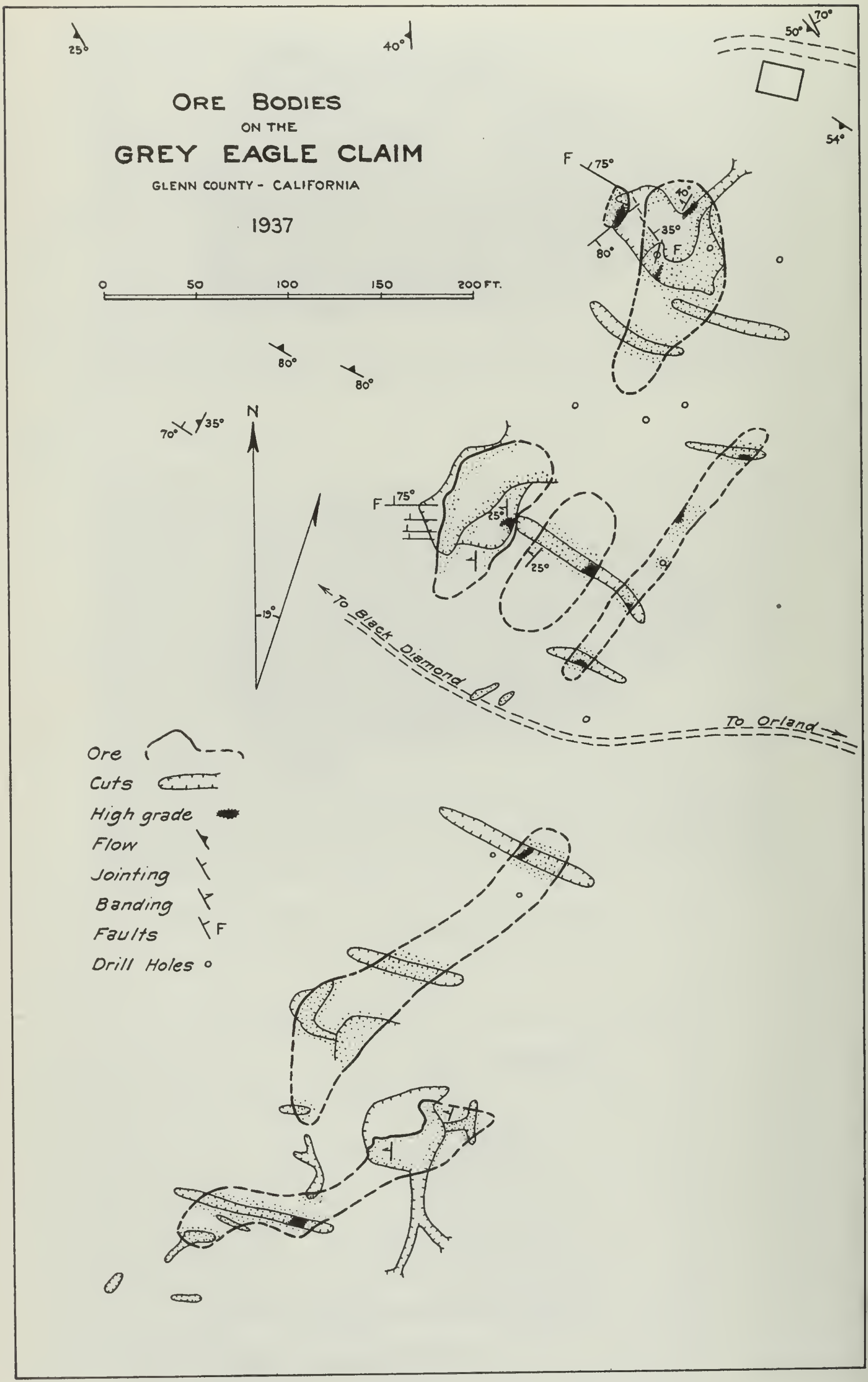
ORE BODIES
ON THE
GREY EAGLE CLAIM
GLENN COUNTY - CALIFORNIA
1937
0
50
100
150
200 FT.
N
19°
To Black Diamond
To Orland
F
75°
80°
40°
35°
25°
70°
50°
54°
Ore
Cuts
High grade
Flow
Jointing
Banding
Faults
Drill Holes

FIG. 26. Plan of Grey Eagle claim orebodies.

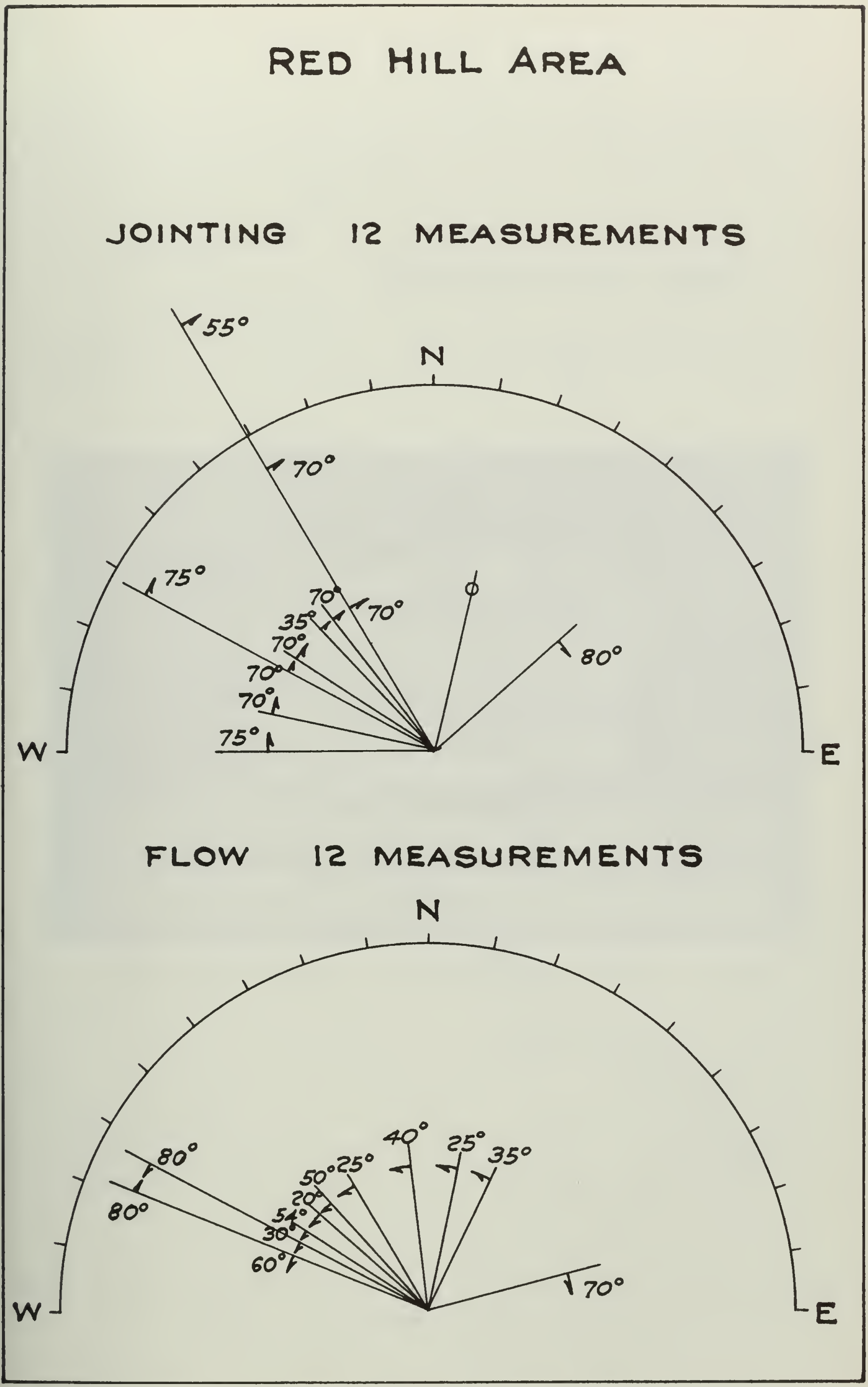
RED HILL AREA
JOINTING 12 MEASUREMENTS
N
55°
70°
75°
70°
70°
35°
70°
70°
70°
75°
80°
W
E
FLOW 12 MEASUREMENTS
N
40°
25°
35°
80°
50°
25°
20°
54°
30°
60°
80°
70°
W
E

FIG. 27. Attitudes of jointing and flow, Grey Eagle deposits, Red Hill group.

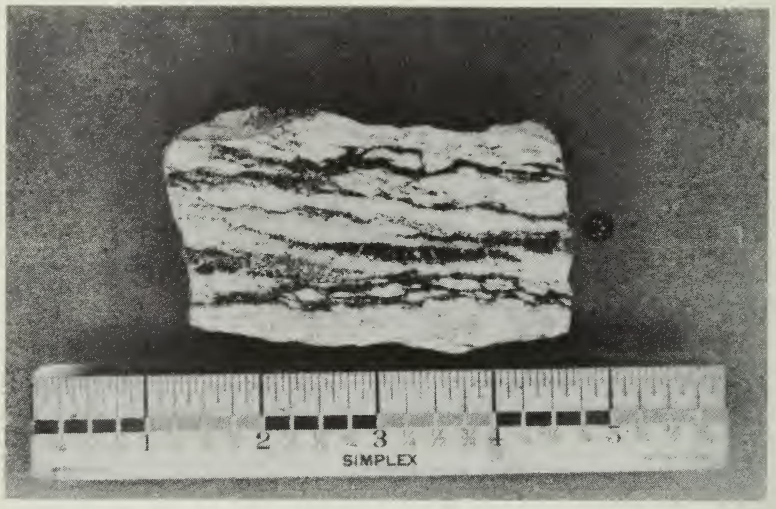
1
2
3
4
5
SIMPLEX

FIG. 28. Lenticular banded chromite in magnesite, Pillikin mine.

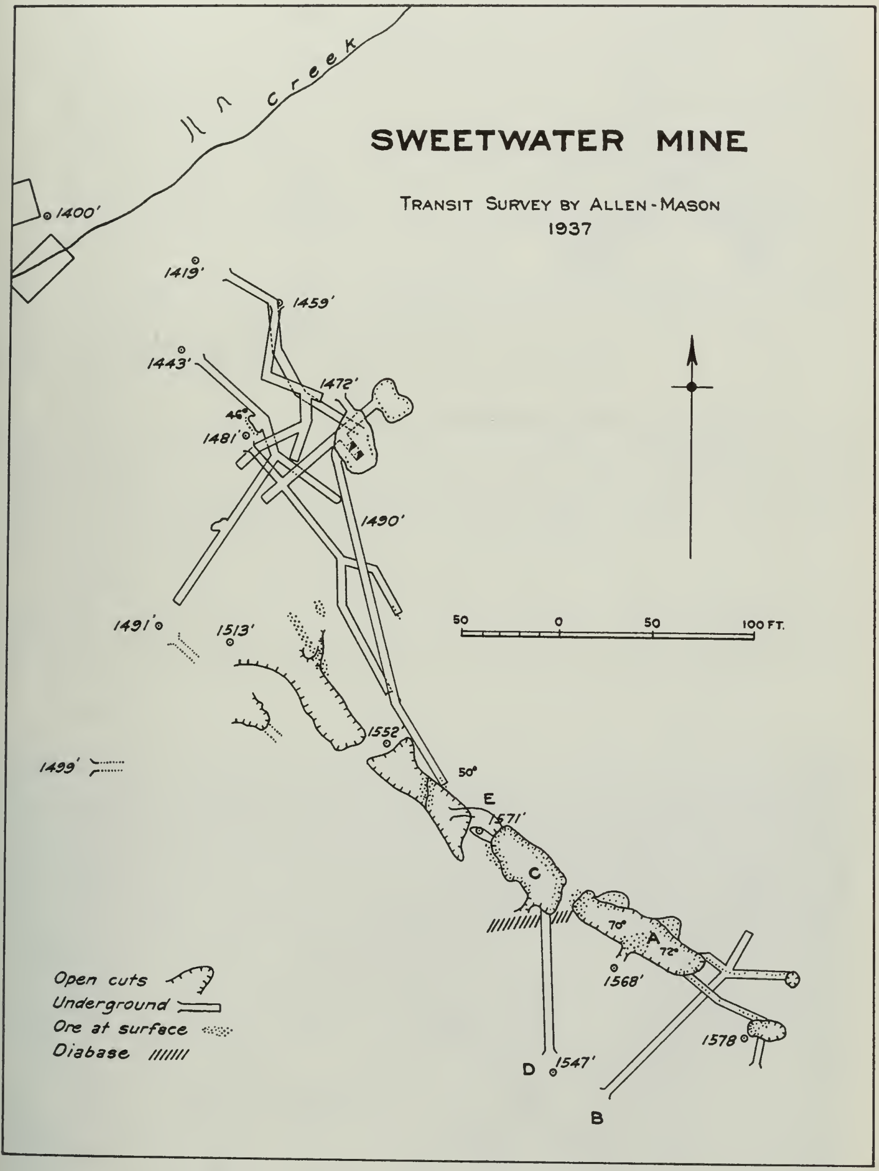
SWEETWATER MINE
TRANSIT SURVEY BY ALLEN-MASON
1937
creek
1400'
1419'
1459'
1443'
1472'
46°
1481'
1490'
1491'
1513'
1499'
1552'
50°
E
1571'
C
A
70°
72°
1568'
1578'
D
1547'
B
50 0 50 100 FT.
Open cuts
Underground
Ore at surface
Diabase

FIG. 29. Transit survey of Sweetwater mine.

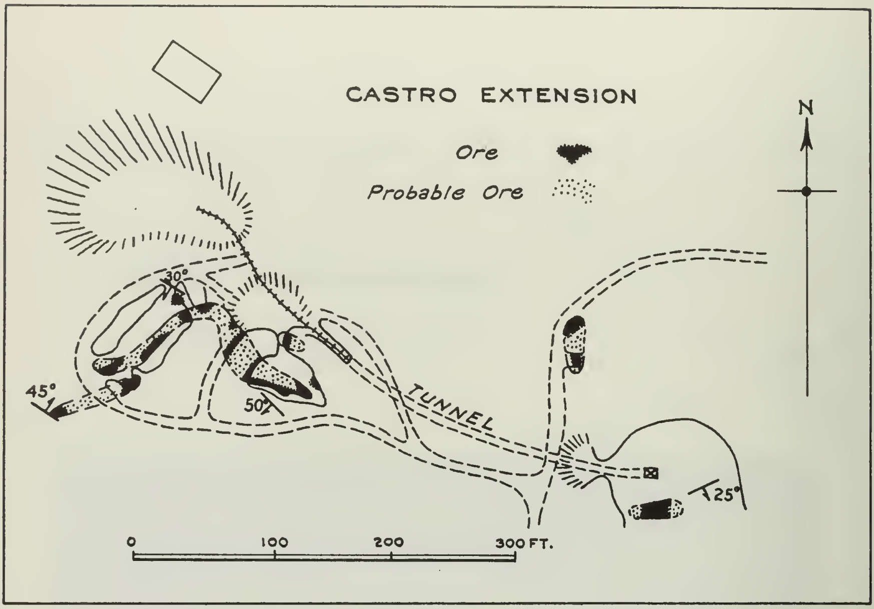
CASTRO EXTENSION
Ore
Probable Ore
N
TUNNEL
30°
45°
50°
25°
0
100
200
300 FT.

FIG. 30. Sketch of orebodies, Castro Extension.

FIG. 31. New London mine workings, San Luis Obispo County.

5 feet of very low-grade milling ore striking N. 60° W. and dipping 50° S. Logan (18, p. 167) says of this property:

> "There has been a considerable production from this property in the past, but on account of low prices it was closed down before the ore bodies were exhausted. Several carloads were shipped (during 1918) . . . but in spite of great care in sorting, it was found nearly impossible to get carloads averaging over 33% chromic oxide. The company consequently set about prospecting in order to see if there was sufficient low-grade ore available to justify construction of a concentrating plant. Work on the hill at the end of the wagon road uncovered a lens 65 feet long and 28 feet thick, which has not yet been bottomed, but has been proven to a depth of about 25 feet. This body carries some bunches of shipping ore, but the major part of it is stated to run about 20% chromic oxide. No attempt will be made to sort out high grade, but the whole lens will be milled. Three other bodies of low-grade ore were also found. When prospecting had revealed enough 20% to 25% ore to give a reserve of over 6,000 tons, the management felt justified in putting up a mill. There is still a large unexplored area. The mill has been built on the hill below the large ore body, and a tunnel has been driven to tap the ore at depth, so that tramming from the working face to the mill bin will be possible . . . Water from the mill is pumped from San Luisito creek, to a 10,000 gallon redwood tank . . . and is collected (again) in a pump below the mill and returned . . ."

The Castro was equipped with a 50-ton concentrating mill during the World War, and some ore of 20-25 percent chromic oxide was concentrated; but in 1937 the mill had been dismantled. The mill had been removed when the property was visited.

Castro No. 2 (21). Castro No. 2 workings lie over 500 feet to the east of the glory-hole on the Castro, and consist of opencuts 60 feet long and up to 20 feet wide and deep. Pierce says that the ore was about 12 feet wide at the center of the cut. It now appears 6 feet wide at the west end, striking N. 65° W. and dipping 55° S. Apparently it is cut off a little further west by a diabase inclusion.

Rawhide (22). Rawhide lies about 500 feet due south of the eastermost workings on the Castro and consists of one cut 6 by 8 by 10 feet from which, according to Pierce, several tons of high-grade ore were removed from a kidney which had a northwest strike.

Estrella (23). Estrella openings lie 700 feet southeast of the Castro No. 2 cut and consist of two short adits. The north adit is 30 feet long, running N. 60° W., and a 2- to 4-inch stringer of high-grade ore 2 feet long shows in the south wall. There is considerable silica (mostly opal) along the joints and fissures in the serpentine, as well as some tremolite. The ore zone is altered but not soft. There is a large amount of black manganese oxide stain on the fissure surfaces.

Twenty feet to the south of this cut another one 20 feet long strikes N. 25° W. and exposes no ore.

About 100 pounds of high-grade ore lies on the dump, and boulders show that the ore-band was at least 8 inches wide. A small cut 50 feet to the northwest shows very narrow stringers of high-grade.

Mescall (24). Mescall lies about 1,000 feet due south of the Estrella across the creek and below the top of the next ridge.

The country rock is much broken and altered, and shows considerable silicification. The opencut extends for 100 feet east and west, and a tunnel with underhand and overhead stopes extends another 100 feet east, giving a total developed length of 200 feet.

The ore strikes N. 70° W. and dips 70° S. It is from 6 inches to 2 feet wide, and may average as much as 30 percent chromic oxide, but it is very irregular, discontinuous, and variable in grade.

There are several other shallow ditches to the west of the main cut, but no ore was seen.

Unnamed deposits in the SW¼ Sec. 28:

At (25) a tunnel, now caved, extends S. 70° W. for 30 feet, showing no ore in place. There is some medium- and low-grade ore from narrow stringers on the dump.

At (26) two cuts show that there must have been some ore, but none could be seen.

At (27) a series of opencuts extend from the road S. 70° E. for 200 feet. Both low- and high-grade ore shows on the dumps, but none is visible in place.

At (28) an opencut extends for 150 feet S. 70° E. and a tunnel seems to have gone in further, with a dump of low-grade milling ore and some high-grade amounting to over 400 tons. Apparently the tunnel ran into a diabase, that rock now appearing on the outer edge of the dump.

Niggerhead (29). Niggerhead has opencuts extending for nearly 200 feet N. 55° W. that have been mined to a depth of 10–20 feet. Another pit lies 100 feet to the west. The ore on the dumps shows that the high-grade ore was apparently cobbed from a low-grade band. No ore was seen in place except in the west cut. Probably the high-grade orebodies are so narrow that mining to any depth would be too expensive, although depth could easily be gained by coming in from the steep north slopes.

Santa Clara (30). Santa Clara claim lies near the center of N½ Sec. 33, and half a mile west of Trinidad.

A shaft at least 20 feet deep (now caved) is said to show ore at the bottom. An opencut was later dug in from the south to within 30 feet of the shaft, and some narrow bodies of high-grade ore taken out of the broken serpentine. At the present time only a small amount of low-grade ore is visible.

Hilltop (31). Hilltop is located about half a mile north of the Santa Clara, up a steep sled road, and over 1,000 feet higher in elevation, within 500 feet of the crest of the range. Here a zone has been prospected by three cuts for 250 feet north and south.

Small stringers of high-grade strike N. 50° E. and dip 50° S. in the north cut. In the center cut about 5 feet of low-grade ore is exposed, and in the lower large cut the ore seems to be about 20 feet wide, but of only 10–15 percent chromic oxide content.

New London (32). New London is located in the SE¼ Sec. 33, near the line of Sec. 4. (See fig. 31.)

Five tunnel entrances are now visible, but all are closed. Maps and a discussion of the underground workings are available (Laizure, C. McK. 25, p. 508) as well as an earlier map by Logan (18, pp. 171-173). The later report by Franke (35, p. 413) has this to say:

> "This mine has been fairly well developed, and when operation ceased in 1918 extensive ore-reserves are said to have been left blocked out. About

> 3,500 tons of ore were shipped from the property during the war period. The ore lenses have a general northwest strike and a uniform dip of about 60° N E. The ore was reported to average 38% chromic oxide and 8-10% silica."

The lowest tunnel is only 20 feet above the creek bed.

Trinidad (33). Trinidad is located in the NE¼ Sec. 33, about half a mile north of the New London. According to Logan (18, p. 171):

> "A tunnel has been driven west 460 feet, and a number of crosscuts have been driven north and south from the tunnel level. Three lenses of chromite have been developed which have a general east and west trend and dip 40-45° north. A winze has been sunk on each lens to depths of 20 feet. It is reported that about 1,000 tons of ore have been developed. At the elevation of the open cut (1,550 feet) an incline has been sunk to a depth of 100 feet to extract ore from the ore bodies developed on tunnel level."

At that time the deposit was visited the underground workings were all caved. The low-grade ore cropping in the large opencuts appears to be as much as 15 feet wide and seems to strike north. "From the information obtained from the underground development, there appears to be a well-defined ore-zone which is approximately 125 feet wide, and has a general north and south course." (Logan, C. A. 18, p. 171).

About 500 feet to the northeast of the main workings an opencut shows a small high-grade lens of ore.

(34). Several large opencuts and caved underground workings lie in the NW¼ Sec. 3, 50 feet above the east fork of Chorro Creek on the east side. No ore was seen in the bedrock or dumps, except a few pieces with a few disseminated crystals. Across the creek 100 yards to the west, another small cut by the road indicates the continuation of this east-west zone.

Pick and Shovel Mine (35). Pick and Shovel mine is located in the E½ Sec. 34, and:

> ". . . was worked more extensively in the past than any chrome deposit in the district, and produced a large tonnage between 1880 and 1890. The old workings consist of 2,500 feet of tunnels, the longest being 900 feet. It bears N. 60° E., and is driven at an elevation of 1,840 feet. The ore occurs in lenses and stringers in a crushed zone. It has been stated that, from one lens of ore encountered at a distance of 560 feet from the tunnel portal there was extracted 800 tons of chrome. The dip of the kidneys of ore was 30° N.W. The chromite was found impregnating the serpentine as well as in almost pure masses. Recently the workings from this tunnel have been reopened and some new lenses of ore developed. At the lower level another tunnel has been driven which has opened up a lens of chromite 50 feet in length by 12 feet thick and 15 feet deep, containing approximately 1,000 tons, and it is reported that the shipments made from this lens run 50% chromic oxide.
>
> "Over 4,000 tons of high grade ore were produced from the mine during the World War. Small shipments have been made from the property since the market collapsed in 1918. O. H. Wolmer drove a 300-foot tunnel on the property in 1929 and 1930 in search of a new ore-body, which he failed to find, but did mine and ship a small tonnage of ore . . . An analysis of ore from the lower drift, made in 1917, showed 51.45% chromic oxide and 1.44% silica. The latter usually averages a little more than this." (Logan, C. A. 18, pp. 174-175)

A map of the underground workings is shown in Franke's report (35).

At the present time (1938) the tunnels are caved and the property is deserted. It is reported that an orebody crops in the creek bed, but this could not be found.

Single Jack (36). Single Jack lies north of the Pick and Shovel and east of the Chorro Creek claims. It was not visited, but consists of at least one tunnel.

Chorro Creek Claims (37). Chorro Creek Claims are located in the NE¼ Sec. 34, up the creek half a mile from the Pick and Shovel. A number of old cuts and tunnels near the top of the ridge show that the overburden of red soil here is very deep and filled with high-grade chromite float over an area of more than an acre. The rock is crushed and altered where visible. No ore other than that in the soil was seen.

> "Considerable chromite was shipped from the property during 1882 and 1883. The workings which are at an elevation of 1,900 feet consist of a few shallow open cuts and prospect holes, and outside of assessment work, no new work was being prosecuted when the property was visited. There is considerable chrome float scattered over the surface of the ridge." (Logan, C. A. 18, p. 169)

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SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

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These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

UNITED STATES SUPREME COURT RENDERS FAR-REACHING DECISION ON POWER PERMITS ON "NAVIGABLE" STREAMS[a]

The United States Supreme Court by a 6-2 opinion on December 16, 1940, rendered a decision of far-reaching effect dealing with the authority of the Federal Power Commission over the development of power projects on streams designated as ''navigable'' even in the face of objections, either statutory or otherwise, from the State in which the development is proposed. Because of its far-reaching implications and effect, as well as specifically to certain streams in California, we here reprint its more important and significant paragraphs:

The United States of America, Petitioner, vs. Appalachian Electric Power Company.	On Writ of Certiorari to the United States Circuit Court of Appeals for the Fourth Circuit.

(December 16, 1940.)

Mr. Justice Reed delivered the opinion of the Court.

This case involves the scope of the Federal commerce power in relation to conditions in licenses, required by the Federal Power Commission, for the construction of hydroelectric dams in navigable rivers of the United States. To reach this issue requires, preliminarily, a decision as to the navigability of the New River, a watercourse flowing through Virginia and West Virginia. The district court and the circuit court of appeals have both held that the New River is not navigable and that the United States can not enjoin the respondent from constructing and putting into operation a hydroelectric dam situated in the river just above Radford, Virginia.

Sections 9 and 10 of the Rivers and Harbors Act of 1899 make it unlawful to construct a dam in any navigable water of the United States without the consent of Congress. By the Federal Water Power Act of 1920, however, Congress created a Federal Power Commission with authority to license the construction of such dams upon specified conditions. Section 23 of that act provided that persons intending to construct a dam in a nonnavigable stream may file a declaration of intention with the commission. If after investigation the commission finds that the interests of interstate or foreign commerce will not be affected, permission shall be granted for the construction. Otherwise construction can not go forward without a license.

The Radford Dam project was initiated by respondent's predecessor, the New River Development Company, which filed its declaration of intention with the Federal Power Commission on June 25, 1925. The commission requested a report from General Harry Taylor, then Chief of Engineers of the War Department. He first reported that the river was navigable, and also that while the water flow from the dam, if not properly regulated, could have an adverse effect on navigation during low water stages in the Kanawha River (of which the New was one of the principal tributaries), such possible adverse effect would not warrant refusing a license to construct the dam if control was maintained by the United States. On review at the commission's request, however, General Taylor rendered a second report, concluding that the New River in its present condition was not navigable and that navigation on the Kanawha would not be adversely affected by the proposed power development. On March 2, 1926, the commission held a hearing on the declaration; the only evidence then submitted was General Taylor's second report.

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[a] The United States Law Week, Vol. 9, No. 25, Dec. 17, 1940.

Respondent, the Appalachian Electric Company, took an assignment of the declaration of intention on August 30, 1926, and several days later filed an application for a license on the commission's suggestion that this would expedite matters and could be withdrawn if it later developed that no Federal license was required. In October, the district engineer of the War Department held a public hearing at Radford. On June 1, 1927, the commission made a finding that the New River was not "navigable waters" within the definition in Section 3(8) of the Federal Water Power Act of 1920 but that (under Section 23 of the act) the project would affect the interests of interstate and foreign commerce. On July 1, 1927, the commission tendered to respondent a standard form license which the respondent refused in April, 1928, principally on the ground that the conditions—especially those concerning rates, accounts and eventual acquisition—were unrelated to navigation. In February, 1930, respondent reiterated that its project was not within the commission's jurisdiction, but nevertheless offered to accept a "Minor-part" license containing only such conditions as would protect the interests of the United States in navigation. In September, 1930, Attorney General Mitchell advised the commission that it could properly issue such a minor-part license; the question submitted by the commission had stated that the New River was neither navigated nor navigable in fact. On November 25, the commission "declined to take action on the application favorable or adverse," on the ground that a court adjudication was desirable. After the establishment of the commission as an independent agency, it held another hearing in February, 1931; in April it denied the application for a minor-part license, directed that the respondent be tendered a standard form license under the act, and ordered it not to proceed without such a license. A minority of the commission then favored a finding that the New River was navigable; the majority, however, thought that question was for the courts and that the commission's jurisdiction was properly based upon Section 23 of the Federal Water Power Act.

On June 8, 1931, the respondent brought an action against the commission to remove a cloud on its title and to restrain interference with the use of its property. This case was dismissed for jurisdictional reasons. While it was pending, on October 12, 1932, the commission without notice adopted a resolution that the New River, from the mouth of Wilson Creek, Virginia, north, was navigable.

The respondent began construction work on the dam about June 1, 1934. On May 6, 1935, the United States filed this bill for an injunction against the construction or maintenance of the proposed dam otherwise than under a license from the Federal Power Commission, and in the alternative a mandatory order of removal. It alleged that the New River is navigable; that the dam would constitute an obstruction to navigation and would impair the navigable capacity of the navigable waters of the United States on the New, Kanawha and Ohio Rivers; that the commission had found the dam would affect the interests of interstate or foreign commerce; and that its construction therefore violated both the Rivers and Harbors Act and the Federal Water Power Act. Respondent denied these allegations, and also set forth a number of separate defenses based on the assumption that the New River was nonnavigable. The fortieth and forty-first paragraphs of the answer, however, set forth defenses relied on by the respondent even if the river were held navigable. The substance of these was (1) that the conditions of any Federal license must be strictly limited to the protection of the navigable capacity of the waters of the United States; and (2) that the commission's refusal to grant the minor-part license containing only such conditions was unlawful, and that any relief should be conditioned upon the commission's granting respondent such a license. By these defenses respondent put in question—in the event of an adverse holding on navigability—the validity of the conditions of the act carried over into the standard form license which relate to accounts, control of operation and eventual acquisition of the project at the expiration of the license.

After trial, in an opinion reinforced by formal findings of fact and law, the district court decided that the New River is not a navigable water of the United States; that the respondent's dam would not obstruct the navigable capacity of the Kanawha or any other navigable river, and would not affect the interests of interstate commerce; that the Power Commission's findings on these matters were not final but subject to the determination of the courts; that the Federal Water Power Act did not vest in the commission authority to require a license in a nonnavigable river; that even if the commission had authority to require some license for a dam in nonnavigable waters, it could not impose conditions having no relation to the protection of the navigable capacity of waters of the United States; and that its effort to impose upon respondent a license containing unlawful conditions barred the United States from relief. The district judge therefore dismissed the bill, but left it open to the Government to assert its rights if future operation of the project interfered with the navigable capacity of the waters of the United States. The Circuit Court of Appeals with one judge dissenting, affirmed. We granted certiorari.

Concurrent Findings. The district court's finding that the New River was not navigable was concurred in by the Circuit Court of Appeals after a careful appraisal of the evidence in the record. Both courts stated in detail the circumstantial facts relating to the use of the river and its physical characteristics, such as volume of water, swiftness and obstructions. There is no real disagreement between the parties here concerning these physical and historical evidentiary facts. But there are sharp divergencies of view as to their reliability as indicia of navigability and the weight which should be attributed to them. The disagreement is over the ultimate conclusion upon navigability to be drawn from this uncontroverted evidence.

The respondent relies upon this court's statement that "each determination as to navigability must stand on its own facts," and upon the conventional rule that factual findings concurred in by two courts will be accepted by this court unless clear error is shown.

In cases involving the navigability of water courses, this court, without expressly passing on the finality of the findings, on some occasions has entered into consideration of the facts found by two courts to determine for itself whether the courts have correctly applied to the facts found the proper legal tests. When we deal with issues such as these before us, facts and their constitutional significance are too closely connected to make the two-court rule a serviceable guide. The legal concept of navigability embraces both public and private interests. It is not to be determined by a formula which fits every type of stream under all circumstances and at all times. Our past decisions have taken due account of the changes and complexities in the circumstances of a river. We do not purport now to lay down any single definitive test. We draw from the prior decisions in this field and apply them, with due regard to the dynamic nature of the problem, to the particular circumstances presented by the New River. To these circumstances certain judicial standards are to be applied for determining whether the complex of the conditions in respect to its capacity for use in interstate commerce render it a navigable stream within the constitutional requirements. Both the standards and the ultimate conclusion involve questions of law inseparable from the particular facts to which they are applied.

Navigability. The power of the United States over its waters which are capable of use as interstate highways arises from the commerce clause of the Constitution. "The Congress shall have Power * * * To regulate Commerce * * * among the several States." It was held early in our history that the power to regulate commerce necessarily included power over navigation. To make its control effective the Congress may keep the "navigable waters of the United States" open and free and provide by sanctions against any interference with the country's water assets. It may legislate to forbid or license dams in the waters; its power over improvements for navigation in rivers is "absolute."

The States possess control of the waters within their borders, "subject to the acknowledged jurisdiction of the United States under the Constitution in regard to commerce and the navigation of the waters of the rivers." It is this subordinate local control that, even as to navigable rivers, creates between the respective governments a contrariety of interests relating to the regulation and protection of waters through licenses, the operation of structures and the acquisition of projects at the end of the license term. But there is no doubt that the United States possesses the power to control the erection of structures in navigable waters.

The navigability of the New River is, of course, a factual question but to call it a fact can not obscure the diverse elements that enter into the application of the legal tests as to navigability. We are dealing here with the sovereign powers of the Union, the Nation's right that its waterways be utilized for the interests of the commerce of the whole country. It is obvious that the uses to which the streams may be put vary from the carriage of ocean liners to the floating out of logs; that the density of traffic varies equally widely from the busy harbors of the seacoast to the sparsely settled regious of the western mountains. The tests as to navigability must take these variations into consideration.

Both lower courts based their investigation primarily upon the generally accepted definition of *The Daniel Ball.*[21]

In so doing they were in accord with the rulings of this court on the basic concept of navigability. Each application of this test, however, is apt to uncover variations and refinements which require further elaboration.

In the lower courts and here, the Government urges that the phrase "susceptible of being used, in their ordinary condition," in the *Daniel Ball* definition, should not be construed as eliminating the possibility of determining navigability in the light of the effect of reasonable improvements. The district court thought the argument inapplicable.

The Circuit Court of Appeals said:

> "If this stretch of the river was not navigable in fact in its unimproved condition, it is not to be considered navigable merely because it might have been made navigable by improvements which were not in fact made. Of course if the improvements had been made the question of fact might have been different."

To appraise the evidence of navigability on the natural condition only of the waterway is erroneous. Its availability for navigation must also be considered. "Natural and ordinary condition" refers to volume of water, the gradients and the regularity of the flow. A waterway, otherwise suitable for navigation, is not barred from that classification merely because artificial aids must make the highway suitable for use before commercial navigation may be undertaken. Congress has recognized this in Section 3(8) of the Water Power Act by defining "navigable waters" as those "which either in their natural or improved condition" are used or suitable for use. The district court is quite right in saying there are obvious limits to such improvements as affecting navigability. These limits are necessarily a matter of degree. There must be a balance between cost and need at a time when the improvement would be useful. When once found to be navigable, a waterway remains so. This is no more indefinite than a rule of navigability in fact as adopted below based upon "useful interstate commerce" or "general and common usefulness for purposes of trade and commerce" if these are interpreted as barring improvements. Nor is it necessary that the improvements should be actually completed or even authorized. The power of Congress over commerce is not to be hampered because of the necessity for reasonable improvements to make an interstate waterway available for traffic.

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[21] 10 Wall. 557, 563:

"* * * Those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water. And they constitute navigable waters of the United States within the meaning of the acts of Congress, in contradistinction from the navigable waters of the States, when they form in their ordinary condition by themselves, or by uniting with other waters, a continued highway over which commerce is or may be carried on with other States or foreign countries in the customary modes in which such commerce is conducted by water."

United States vs. *Appalachian Electric Power Co.*, 23 F. Supp. 83, 98; same, 107 F. (2d) 769, 780.

Of course there are difficulties in applying these views. Improvements that may be entirely reasonable in a thickly populated, highly developed, industrial region may have been entirely too costly for the same region in the days of the pioneers. The changes in engineering practices or the coming of new industries with varying classes of freight may affect the type of the improvement. Although navigability to fix ownership of the river bed or riparian rights is determined as the cases just cited in the notes show, as of the formation of the Union in the original States or the admission to statehood of those formed later, navigability, for the purpose of the regulation of commerce, may later arise. * * *

Nor is it necessary for navigability that the use should be continuous. The character of the region, its products and the difficulties or dangers of the navigation influence the regularity and extent of the use. Small traffic compared to the available commerce of the region is sufficient. Even absence of use over long periods of years, because of changed conditions, the coming of the railroad or improved highways does not affect the navigability of rivers in the constitutional sense. It is well recognized too that the navigability may be of a substantial part only of the waterway in question. Of course, these evidences of nonnavigability in whole or in part are to be apprised in totality to determine the effect of all. * * *

Use of a stream long abandoned by water commerce is difficult to prove by abundant evidence. Fourteen authenticated instances of use in a century and a half by explorers and trappers, coupled with general historical references to the river as a water route for the early fur traders and their supplies in pirogues and Durham or flat bottomed craft similar to the keelboats of the New, sufficed upon that phase in the case of the Des Plaines. Nor is lack of commercial traffic a bar to a conclusion of navigability where personal or private use by boats demonstrates the availability of the stream for the simpler types of commercial navigation.

The evidence of actual use of the Radford-Wiley's Falls section for commerce and for private convenience, when taken in connection with its physical condition make it quite plain that by reasonable improvement the reach would be navigable for the type of boats employed on the less obstructed sections. Indeed the evidence detailed above is strikingly similar to that relied upon by this court in *United States* vs. *Utah* to establish the navigability of the Colorado from Cataract Canyon to the Utah-Arizona boundary line. There had been 17 through trips over a period of 60 years from the original exploration; and these together with sporadic trips on parts of the stretch, and considerable use—in connection with gold placer mining—of other parts from 1888 to 1915, sufficed to sustain navigability.

Effect of Improvability. Respondent denied the practicability of artificial means to bring about the navigability of the New River and the effectiveness of any improvement to make the river a navigable water of the United States. The Government supported its allegation of improvability by pointing out that the use of the section for through navigation and local boating on favorable stretches of the Radford-Wiley's Falls reach showed the feasibility of such use and that little was needed in the way of improvements to make the section a thoroughfare for the typical, light commercial traffic of the area. Keelboats, eight feet wide, drawing two feet, were the usual equipment. In the 1872 report of the Chief of Engineers, Major Craighill in charge of New River reports that to get ''good sluice navigation of two feet at all times'' for 54 miles up from the mouth of the Greenbrier River, near Hinton would cost $30,000 and for 128 miles, Greenbrier to the lead mines (above Allisonia), would cost $100,000. The depth over the shoals could be increased to two feet without ''too much increase of velocity of the current.'' This recommendation was based on Hutton's mile-by-mile survey and includes all of the Radford-Wiley's Falls section.

The improvements were undertaken beginning in 1877. As the region was becoming better developed, a higher type of improvement became desirable, wider sluice ways and a deeper channel, usable by small steamboats. Work went forward above Hinton and above Radford to meet the pressing demands of the communities. Annual reports of the Chief of Engineers assumed or reaffirmed the navigability of the entire river above Hinton and the practicality of the improvements. By 1891, $109,733.21 had been spent. It was in that year estimated $159,000 more would be required to complete the project the full length from Wilson Creek to Hinton. Useful navigation moved regularly between Hinton and near Glen Llyn and between Radford and Allisonia. About half of the reach between Hinton and Allisonia was improved. The Radford-Wiley's Falls section was never improved. It was reported that conditions had changed and the project should not be completed. The provisions for improvements were repealed in 1902. By 1912 the region's need for use of the river had so diminished that the army engineers advised against undertaking improvements again, and even referred to the cost as ''prohibitive.'' From the use of the Radford-Wiley's Falls stretch and the evidence as to its ready improvability at a low cost for easier keelboat use, we conclude that this section of the New River is navigable. It follows from this, together with the undisputed commercial use of the two stretches above Radford and Hinton, that the New River from Allisonia, Virginia, to Hinton, West Virginia, is a navigable water of the United States.

License Provisions. The determination that the New River is navigable eliminates from this case issues which may arise only where the river involved is nonnavigable. But even accepting the navigability of the New River, the respondent urges that certain provisions of the license, which seek to control affairs of the licensee, are unconnected with navigation and are beyond the power of the commission, indeed beyond the constitutional power of Congress to authorize.

The issue arises because of the prayer of the bill that the respondent be compelled to accept the license as required by law or remove the dam as an obstruction and the answer of the respondent that the license required by law and tendered to it by the commission contains provisions, unrelated to navigation or the protection of navigable capacity, which are beyond the constitutional authority of Congress to require on account of the Fifth and Tenth Amendments. There is no contention that the provisions of the license are not authorized by the statute. In the note below [65] the chief statutory conditions for a license are epitomized. The license offered the respondent on May 5, 1931, embodied these statutory requirements and we assume it to be in conformity with the existing administration of the Power Act. We shall pass upon the validity of only those provisions of the license called to our attention by the respondent as being unrelated to the purposes of navigation. These are the conditions derived from Sections 10a, 10c, 10d, 10e and 14. We do not consider that the validity of other clauses has been raised by the respondent's general challenge to the constitutionality of any provision "other than those relating solely to the protection" of navigable waters. It should also be noted that no complaint is made of any conditions of the license dependent upon the authorization of § 10g, the omnibus clause requiring compliance with such other conditions as the commission may require.

The petitioner suggests that consideration of the validity of Section 14, the acquisition clause, and the license conditions based upon its language are properly to be deferred until the United States undertakes to claim the right to purchase the project on the license terms 50 years after its issuance. Assuming that the mere acceptance of a license would not later bar the objection of unconstitutional conditions, even when accompanied by a specific agreement to abide by the statute and license, we conclude that here the requirements of Section 14 so vitally affect the establishment and financing of respondent's project as to require a determination of their validity before finally adjudging the issue of injunction.

The respondent's objections to the statutory and license provisions, as applied to navigable streams, are based on the contentions (1) that the United States' control of the waters is limited to control for purposes of navigation, (2) that certain license provisions take its property without due process, and (3) that the claimed right to acquire this project and to regulate its financing, records and affairs, is an invasion of the rights of the States, contrary to the Tenth Amendment.

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[65] § 4 (a) of the Act allows the Commission to regulate the licensee's accounts.

§ 6 limits licenses to 50 years.

§ 8 requires Commission approval for voluntary transfers of licenses or rights granted thereunder.

§ 10 (a) as amended in 1935, requires that the project be best adapted to a comprehensive plan for improving or developing the waterway for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, and for other beneficial public uses, including recreational purposes. Under § 10 (c) the licensee must maintain the project adequately for navigation and for efficient power operation, must maintain depreciation reserves adequate for renewals and replacements, and must conform to the Commission's regulations for the protection of life, health and property; (d) out of surplus earned after the first 20 years above a specified reasonable rate of return, the licensee must maintain amortization reserves to be applied in reduction of net investment; (e) the licensee must pay the United States reasonable annual charges for administering the act, and during the first 20 years the United States is to expropriate excessive profits until the state prevents such profits; (f) the licensee may be ordered to reimburse those by whose construction work it is benefited.

By § 11. for projects in navigable waters of the United States the Commission may require the licensee to construct locks, etc., and to furnish the United States free of cost (a) lands and rights-of-way to improve navigation facilities and (b) power for operating such facilities.

§ 14 gives the United States the right, upon expiration of a license, to take over and operate the project by paying the licensee's "net investment" as defined, not to exceed fair value of the property taken. However, the right of the United States or any State or municipality to condemn the project at any time is expressly reserved.

§ 19 allows State regulation of service and rates; if none exists, the Commission may exercise such jurisdiction.

Forty-one States join as amici in support of the respondent's arguments. While conceding, as of course, that Congress may prohibit the erection in navigable waters of the United States of any structure deemed to impair navigation, the Attorneys General speaking for the States insist that this power of prohibition does not comprehend a power to exact conditions, which are unrelated to navigation, for the permission to erect such structures. To permit, the argument continues, the imposition of licenses involving conditions such as this acquisition clause, enabling the Federal Government to take over a natural resource such as waterpower, allows logically similar acquisition of mines, oil or farmlands as consideration for the privilege of doing an interstate business. The States thus lose control of their resources and property is withdrawn from taxation in violation of the Tenth Amendment.

Further, the point is made that a clash of sovereignty arises between the license provisions of the Power Act and State licensing provisions. The Commonwealth of Virginia advances forcibly its contention that the affirmative regulation of water-power projects on its navigable streams within its boundaries rests with the State, beyond that needed for navigation. "While the supremacy of the Federal Government in its own proper sphere, as delineated in the Constitution, is cheerfully conceded, yet just as earnestly does Virginia insist upon the supremacy of her own government in its proper field as established by that instrument." Virginia has a Water Power Act. It, too, offers a 50-year license, with the right to use the natural resources of the State, the stream flow and the beds of the water courses for the period of the license or its extensions subject to State condemnation at any time on Virginia's terms for ascertainment of value. Operation is likewise regulated by State law. The Commonwealth objects that the development of its water power resources is subjected to Federal Power Act requirements such as are detailed above in stating the respondent's objection, even to the point that Virginia itself may not build and operate a dam in navigable water without authorization and regulation by the Federal Government.

The briefs and arguments at the bar have marshaled reasons and precedents to cover the wide range of possible disagreement between Nation and State in the functioning of the Federal Power Act. To predetermine, even in the limited field of water power, the rights of different sovereignties, pregnant with future controversies, is beyond the judicial function. The courts deal with concrete legal issues, presented in actual cases, not abstractions. The possibility of other uses of the coercive power of license, if it here is upheld, if not before us. We deem the pictured extremes irrelevant save as possibilities for consideration in determining the present question of the validity of the challenged license provisions. To this we limit this portion of our decision.

The respondent is a riparian owner with a valid State license to use the natural resources of the State for its enterprise. Consequently it has as complete a right to the use of the riparian lands, the water, and the river bed as can be obtained under State law. The State and respondent, alike, however, hold the waters and the lands under them subject to the power of Congress to control the waters for the purpose of commerce. The power flows from the grant to regulate, i.e., to "prescribe the rule by which commerce is to be governed." This includes the protection of navigable waters in capacity as well as use. This power of Congress to regulate commerce is so unfettered that its judgment as to whether a structure is or is not a hindrance is conclusive. Its determination is legislative in character. The Federal Government has domination over the water power inherent in the flowing stream. It is liable to no one for its use or nonuse. The flow of a navigable stream is in no sense private property; "that the running water in a great navigable stream is capable of private ownership is inconceivable." Exclusion of riparian owners from its benefits without compensation is entirely within the Government's discretion.

Possessing this plenary power to exclude structures from navigable waters and dominion over flowage and its product, energy, the United States may make the erection or maintenance of a structure in a navigable water dependent upon a license. This power is exercised through Section 9 of the Rivers and Harbors Act of 1899 prohibiting construction without Congressional consent and through Section 4(e) of the present Power Act.

It is quite true that the criticized provisions summarized above are not essential to or even concerned with navigation as such. Respondent asserts that the rights of the United States to the use of the waters is limited to navigation. It is pointed out that the Federal sovereignty over waters was so described in *Port of Seattle* vs. *Oregon & Washington Railroad Company, United States* vs. *Oregon, Kansas* vs. *Colorado, United States* vs. *River Rouge Company,* and *Wisconsin* vs. *Illinois.* The first two of these cases centered around the issue of title to land under navigable water. Nothing further was involved as to the use of the water than its navigability. In *Kansas* vs. *Colorado* the point was the Government's advocacy of the doctrine of sovereign and inherent power to justify the United States taking charge of the waters of the Arkansas to control the reclamation of arid lands (pp. 85-89). There was found no constitutional authority for irrigation in the commerce clause or the clause relating to property of the United States. It can not be said, however, that the case is authority for limiting Federal power over navigable waters to navigation, especially since the stretch of the Arkansas River involved in the dispute was asserted by the Government to be nonnavigable (p. 86). In the *River Rouge* controversy, this court spoke of the limitation "to the control thereof for the purposes of navigation." But there, too, it was a question of the riparian owner's use of his property for access to the channel, a use fixed by State law. The conclusion that the United States could not interfere, except for navigation, with his right of access to navigable water, required no appraisal of other rights. *Wisconsin* vs. *Illinois* is a part of the Chicago Drainage Canal litigation. In so far as pertinent here, it merely decided that under a certain Federal statute there was no authority for diversion of the waters of Lake Michigan for sanitary purposes (p. 418). There is no consideration of the constitutional power to use water for other than navigable purposes, though it is plain that other advantages occur (pp. 415, 419).

In our view, it can not properly be said that the constitutional power of the United States over its waters is limited to control for navigation. By navigation respondent means no more than operation of boats and improvement of the waterway itself. In truth the authority of the United States is the regulation of commerce on its waters. Navigability in the sense just stated, is but a part of this whole. Flood protection, watershed development, recovery of the cost of improvements through utilization of power are likewise parts of commerce control. As respondent soundly argues, the United States can not by calling a project of its own ''a multiple purpose dam'' give to itself additional powers, but equally truly the respondent can not, by seeking to use a navigable waterway for power generation alone, avoid the authority of the Government over the stream. The authority is as broad as the needs of commerce. Water power development from dams in navigable streams is from the public's standpoint a by-product of the general use of the rivers for commerce. To this general power, the respondent must submit its single purpose of electrical production. The fact that the commission is willing to give a license for a power dam only is of no significance in appraising the type of conditions allowable. It may well be that this portion of the river is not needed for navigation at this time. Or that the dam proposed may function satisfactorily with others, contemplated or intended. It may fit in as a part of the river development. The point is that navigable waters are subject to national planning and control in the broad regulation of commerce granted the Federal Government. The license conditions to which objection is made have an obvious relationship to the exercise of the commerce power. Even if there were no such relationship the plenary power of Congress over navigable waters would empower it to deny the privilege of constructing an obstruction in those waters. It may likewise grant the privilege on terms. It is no objection to the terms and to the exertion of the power that ''its exercise is attended by the same incidents which attend the exercise of the police power of the states.'' The Congressional authority under the commerce clause is complete unless limited by the Fifth Amendment.

The respondent urges that as riparian owner with State approval of its plans, it is entitled to freedom in the development of its property and particularly can not be compelled to submit to the acquisition clause with a price fixed at less than a fair value, in the eminent domain sense, at the time of taking. Such a taking, it is contended, would violate the Fifth Amendment. It is now a question whether the Government in taking over the property may do so at less than a fair value. It has been shown, note 77, *supra,* that there is no private property in the flow of the stream. This has no assessable value to the riparian owner. If the Government were now to build the dam, it would have to pay the fair value, judicially determined, for the fast land; nothing for the water power. We assume without deciding that by compulsion of the method of acquisition provided in Section 14 of the Power Act and the tendered license, these riparian rights may pass to the United States for less than their value. In our view this ''is the price which (respondents) must pay to secure the right to maintain their dam.'' The quoted words are the conclusion of the opinion in *Fox River Company* vs. *Railroad Commission.* The case is decisive on the issue of confiscation. It relates to an acquisition clause in a Wisconsin license by which a dam in navigable water of the State might be taken over at such a price as would, this court assumed, amount to violation of the due process clause of the Fourteenth Amendment if it were not for the license provision. Title to the bank and bed were in the objector, just as, by virtue of the State's license and the riparian ownership, all rights here belong to respondent. There, as here, the rights were subject to governmental ''control of navigable waters.'' The fact that the *Fox River* case involved a State and that this case involves the United States is immaterial from the due process standpoint. Since the United States might erect a structure in these waters itself, even one equipped for electrical generation, it may constitutionally acquire one already built.

Such an acquisition or such an option to acquire is not an invasion of the sovereignty of a State. At the formation of the Union, the States delegated to the Federal Government authority to regulate commerce among the States. So long as things done within the States by the United States are valid under that power, there can be no interference with the sovereignty of the State. It is the nondelegated power which under the Tenth Amendment remains in the State or the people. The water power statutes of the United States and Virginia recognize the difficulties of our dual system of government by providing, each in its own enactments, for the exercise of rights of the other.

Reversed and remanded to the District Court with instructions to enter an order enjoining the construction, maintenance or operation of the Radford project otherwise than under a license, accepted by the respondent within a reasonable time, substantially in the form tendered respondent by the Federal Power Commission on or about May 5, 1931, or in the alternative, as prayed in the bill.

The CHIEF JUSTICE took no part in the consideration or decision of this case.

MR. JUSTICE ROBERTS

The judgment of reversal rests on the conclusion that New River is navigable—a conclusion resting on findings of fact, made here *de novo,* and in contradiction of the concurrent findings of the two courts below. I am of opinion that the judgment of the Circuit Court of Appeals should be affirmed, first, because this court ought to respect and give effect to such concurrent findings which have substantial support in the evidence; secondly, because the evidence will not support contrary findings if the navigability of New River be tested by criteria long established.

1. A river is navigable in law if it is navigable in fact. Indeed the issue of navigability *vel non* is so peculiarly one of fact that a determination as to one stream can have little relevancy in determining the status of another. As this court has said, ''each determination as to navigability must stand on its own facts.''

The evidence supports—indeed I think it requires—a finding that, applying accepted criteria, New River is not, and never has been, in fact navigable. On this record the rule of decision, many times announced by this court, that the concurrent findings of fact of two lower courts, if supported by substantial evidence, will be accepted here, requires affirmance of the judgment. The rule applies not only to evidentiary facts but to conclusions of fact based thereon. Moreover, it has been the basis of this court's decision in a suit involving the question of navigability. Invoking the rule, this court in *Brewer-Elliott Oil & Gas Co.* vs. *United States*, 260 U. S. 77, 86, declined to review a judgment based on a concurrent finding of two lower courts that a stream "was not, and had never been, navigable within the adjudged meaning of that term."

The cases cited for the proposition that where navigability was an issue this court has reconsidered the facts found by the courts below to determine whether they have correctly applied the proper legal tests do not, when the questions involved are understood, lend support to the action of the court in this case.

The petitioner, in effect, asks this court to convict the courts below of error in determining the credibility, weight and relevance of the evidence. But that determination is peculiarly within their province, as this court has often said. The doctrine applies in this case with especial force. The respondent says, without contradiction, that the Government in its brief in the Circuit Court stated: "It can not be said that the New River presents a 'clear case' of navigability or non-navigability * * *." Yet this court is asked to ignore concurrent findings on the subject.

If the evidence may fairly support these findings, the courts below can be convicted of error only in applying an erroneous rule of law to the facts found.

Examination of the opinions below shows that the courts faithfully followed the decisions of this court in applying the law to the facts. They adopted the definition and applied the criteria this court has announced in appraising the effect of the facts found.

As shown by the cases cited in the margin, a stream to be navigable in fact must have "a capacity for general and common usefulness for purposes of trade and commerce." Exceptional use or capability of use at high water or under other abnormal conditions will not suffice. Moreover, the stream must be used, or available to use, "for commerce of a substantial and permanent character." Where the stream "has never been impressed with the character of navigability by past use in commerce, * * * commerce actually *in esse* or at least *in posse* is essential to navigability" and "a theoretical or potential navigability or one that is temporary, precarious and unprofitable is not sufficient." The most important criterion by which to ascertain the navigability of a stream is that navigability in fact must exist under "natural and ordinary conditions." Application of these tests by the court below to the evidence in the case led to but one conclusion—that New River has not been, and is not now, a navigable water of the United States. If the findings below had been the other way, the Government would be here strenuously contending that they could not be set aside, as it successfully did in *Brewer-Elliott Oil & Gas Co.* vs. *United States, supra.*

2. The petitioner contends that the application of the accepted tests to the facts disclosed amounts to a ruling of law, and asserts that error in their application is reviewable. As I read the court's opinion, the argument is not found persuasive. While apparently indorsing it in the abstract the court, instead of relying on it, adopts two additional tests in the teeth of the uniform current of authority. If anything has been settled by our decisions it is that, in order for a water to be found navigable, navigability in fact must exist under ''natural and ordinary conditions.'' This means all conditions, including a multiplicity of obstacles, falls and rapids which make navigation a practical impossibility. The court now, however, announces that ''natural and ordinary conditions'' refers only to volume of water, gradients, and regularity of flow. No authority is cited and I believe none can be found for thus limiting the connotation of the phrase. But further the court holds, contrary to all that has heretofore been said on the subject, that the natural and ordinary condition of the stream, however impassable it may be without improvement, means that if, by ''reasonable'' improvement, the stream may be rendered navigable then it is navigable without such improvement; that ''there must be a balance between cost and need at a time when the improvement would be useful.'' No authority is cited and I think none can be cited which countenances any such test. It is of course true that if a stream in its natural and ordinary condition is navigable it does not cease to be so because improvements have bettered the conditions of navigation. But the converse is not true—that where a stream in its natural and ordinary condition is nonnavigable, a project to build a canal along its entire course, or dams and locks every few miles, at enormous expense, would render it a navigable water of the United States. Who is to determine what is a reasonable or an unreasonable improvement in the circumstances; or what is a proper balance between cost and need? If these questions must be answered it is for Congress, certainly not for this court to answer them. If this test be adopted, then every creek in every State of the Union which has enough water, when conserved by dams and locks or channeled by wing dams and sluices, to float a boat drawing two feet of water, may be pronounced navigable because, by the expenditure of some enormous sum, such a project would be possible of execution. In other words, Congress can create navigability by determining to improve a non-navigable stream.

If this criterion be the correct one, it is not seen how any stream can be found not to be navigable nor is it seen why this court and other Federal courts have been at pains for many years to apply the other tests mentioned when the simple solution of the problem in each case would have been to speculate as to whether, at ''reasonable'' cost, the United States could render a most difficult and forbidding mountain torrent suitable for the least pretentious form of water traffic. In the light of the court's opinion, if this test be applied to the New River it must, of course, be admitted that by blasting out channels through reefs and shoals, by digging canals around falls and rapids, and possibly by dams and locks, the New River could be rendered fit for some sort of commercial use. What the expense would be no one knows. Obviously it would be enormous. Congress in the past has undertaken to render the river navigable and decades ago gave up the attempt.

Still we are told that, at ''reasonable'' cost, the thing can be done, and so the stream is navigable.

In the light of the grounds upon which the decision of the court is based it hardly seems necessary to comment on the evidence, for it is in the main addressed to issues no longer in the case. The two courts below have analyzed and examined it in detail and reference to their carefully considered opinions suffices. I think the conclusion reached by the courts below must stand unless the two novel doctrines now announced be thrown into the scale to overcome it.

Mr. Justice McReynolds concurs in this opinion.

Francis Biddle, Solicitor General (John W. Aiken, Warner W. Gardner, David W. Robinson, Jr., General Counsel, Federal Power Commission, Gregory Hankin, and Willard W. Gatchell with him on the brief) for petitioner; Raymond T. Jackson (M. F. Millikan, A. Henry Mosle, Creswell M. Micou, Fraser M. Horn, Wendell W. Forbes, M. W. Belcher, Jr., and John L. Abbot with him on the brief) for respondent; Abram P. Staples, Attorney General of Virginia, for Commonwealth of Virginia as amicus curiae, by special leave of Court; brief as amici curiae was filed by the Attorneys General, respectively, in behalf of Alabama, Arizona, California, Colorado, Connecticut, Delaware, Florida, Idaho, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Mississippi, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, Wyoming; Hubert Meredith, Attorney General, and M. B. Holifield, Assistant Attorney General, filed brief on behalf of the Commonwealth of Kentucky as amicus curiae; Clarence W. Meadows, Attorney General, filed brief on behalf of the State of West Virginia as amicus curiae; and John E. Martin, Attorney General, Adolph Kanneberg, Counsel for Public Service Commission, and Newell S. Boardman, Assistant Attorney General, filed brief on behalf of the State of Wisconsin as amicus curiae.

SECURITIES AND EXCHANGE COMMISSION

Washington

SECURITIES ACT OF 1933

Release No. 2410

In a substantial revision of its procedures and its rules in connection with the granting of exemptions under the Securities Act of 1933, the Securities and Exchange Commission announced December 3, 1940, that it had repealed its present rules 200 to 210 inclusive and substituted a single simplified regulation containing a single integrated exemption which in many respects substantially broadens the availability of the exemption.

Section 3 (b) of the Securities Act gives the commission the power, under such rules and regulations as it may deem necessary in the public interest and for the protection of investors, to exempt from the registration requirements of the act security issues up to and including $100,000. Heretofore the commission has given a total exemption on issues up to $30,000. As to other issues not in excess of $100,000, an exemption, up to now, has been available only upon varying terms and conditions, such as the compliance with the laws of the States in which the securities were sold, or the use of a prospectus containing certain specified information. Where prospectuses have heretofore been required, they have been examined in the registration division of the commission.

The new simplified procedure does not require the use of a prospectus in any case. To avail itself of the exemption, a domestic issuer will now need only to send to the nearest regional office a letter notifying that office of its intention to sell, together with any selling literature it may plan to use. This letter of notification need contain only such information as the name of the company, the name of the underwriters, the name of the issue to be sold and a brief summary of the intended use of the proceeds. The issuer can give this notice, at its option, either through an informal letter or through the use of a two-page form which will be supplied on request for its convenience. Where the issuer chooses to use a prospectus, the regulation indicates certain skeleton information to be included.

A broadened exemption is available in several important respects under the new regulation. For example, the commission takes a new position as to future sales of the securities of the same issuer. Heretofore the commission rules have been such that, if the offering was a part of a larger financial program, involving the future sale of additional securities of the same class, the exemption was not available. The new regulation specifically states that the exemption is available even if ''it is contemplated that after the termination of the offering an offering of additional securities will be made. This will apply in instances, among others, where issuers wish to make annual offerings of already outstanding securities for such purposes as employees' participation plans. In such instances, where the offering is not over $100,000, the exemption will be available.

Furthermore, the exemption is now available to issuers and their controlling stockholders even though each may wish to offer $100,000 under Regulation A within a single year. Heretofore, in such instances, a registration statement has been necessary.

The new regulation shifts the commission's administrative emphasis from the disclosure requirements of the act to the fraud prevention provisions. The examination procedure which has been followed in the past will be abandoned. The use of a prospectus is no longer required, although any selling literature which is employed must be forwarded to the appropriate regional office for its information. The new regulation will be administered from the regional offices under the usual supervision from Washington.

It is hoped that the shifting of this activity to the regional offices will further simplify the problem of compliance with the act by smaller issuers.

The new regulation becomes effective December 9, 1940.

The text of the commission's action follows:

The Securities and Exchange Commission, acting pursuant to authority conferred upon it by the Securities Act of 1933, particularly Sections 3 (b) and 19 (a) thereof, and finding such action necessary and appropriate in the public interest and for the protection of investors and necessary for the execution of the functions vested in it by the said act, hereby takes the following action:

1. Rules 200 to 210, inclusive, of Regulation A of the General Rules and Regulations under the act are rescinded effective January 1, 1941, except as to issues of securities bona fide offered to the public on or before such date under any exemption contained in any of such rules.

2. The following new rules under Regulation A and Form S-3b-1 are adopted, effective December 9, 1940.

REGULATION A. GENERAL EXEMPTION

Rule 220. Securities Exempted

(a) Except as provided in Rule 221, all securities offered in accordance with the terms and conditions of Regulation A, by, on behalf of, or for the benefit of an issuer shall be exempt from registration provided the aggregate offering price of the following shall not exceed $100,000:

(1) The securities of the issuer proposed to be presently offered by, on behalf of, or for the benefit of the issuer pursuant to Regulation A,

(2) All securities of the issuer currently being offered by, on behalf of, or for the benefit of the issuer under Regulation A,

(3) All securities of the issuer previously sold by, on behalf of, or for the benefit of the issuer pursuant to an offering under Regulation A commenced within one year prior to the commencement of the proposed offering, and

(4) All securities of the issuer neither registered nor exempt from registration nor issued in an exempt transaction which were sold by,

on behalf of, or for the benefit of the issuer within one year prior to the commencement of the proposed offering.

(b) Except as provided in Rule 221, all securities offered in accordance with the terms and conditions of Regulation A by, on behalf of, or for the benefit of any person or persons controlling, controlled by, or under common control with an issuer shall be exempt from registration if the aggregate offering price of the following shall not exceed $100,000:

(1) The securities of the issuers proposed to be presently offered by, on behalf of, or for the benefit of such person or persons pursuant to Regulation A,

(2) All securities of the issuer currently being offered by, on behalf of, or for the benefit of such person or persons under Regulation A,

(3) All securities of the issuer previously sold by, on behalf of, or for the benefit of such person or persons pursuant to an offering under Regulation A commenced within one year prior to the commencement of the proposed offering, and

(4) All securities of the issuer neither registered nor exempt from registration nor issued in an exempt transaction which were sold by, on behalf of, or for the benefit of such person or persons within one year prior to the commencement of the proposed offering.

(c) Notwithstanding the provisions of paragraphs (a) and (b), (1) securities offered to a single holder of the majority of the outstanding voting stock of the issuer in connection with a pro rata offering to stockholders, need not be included in determining the amount of securities which may be offered pursuant to this regulation; and (2) securities exchanged for outstanding securities, claims or property in connection with a bona fide recapitalization or reorganization need not be included in computing the amount of securities which may be offered pursuant to this regulation otherwise than in such an exchange.

(d) If the aggregate offering price of the securities enumerated in either paragraph (a) or (b) above does not exceed $100,000, the offering may be made pursuant to Regulation A even though it is contemplated that after the termination of the offering an offering of additional securities will be made.

(e) The aggregate offering price of assessable securities shall include the aggregate amount of all assessments legally leviable thereon at the time of the offering thereof or at any time thereafter.

(f) Where securities are offered "at the market" the aggregate offering price thereof shall be computed upon the basis of the market price as established by bona fide sales made on the first day of the offering.

(g) Where securities are offered in exchange for outstanding securities, claims or property the aggregate offering price thereof shall be computed upon the basis of the market value of the securities, claims or property to be received in exchange as established by bona fide sales made within a reasonable time; if there have been no such sales the aggregate offering price shall be computed upon the basis of the fair value, as determined by some accepted standard, of the securities, claims or property to be received in exchange.

Rule 221. Securities Excluded From Exemption

No exemption under this regulation shall be available for—

(a) Securities of investment trusts or investment companies;

(b) Voting trust certificates;

(c) Fractional undivided interests in oil or gas rights as defined in rule 300, or similar interests in other mineral rights;

(d) Certificates of interests as defined in Rule 360;

(e) Any securities issued by an individual who is a resident of a foreign country, a corporation incorporated in a foreign country, or any other person organized under the laws of, or having its principal place of business in, a foreign country;

(f) Any securities of an issuer so long as a registration statement of the issuer or of any person controlling, controlled by, or under common control with, the issuer is the subject of pending proceedings under Section 8 (b) or 8 (d) of the act or of an order entered under either of these sections;

(g) Any securities of an issuer if the issuer, any promoter of the issuer presently connected with the issuer in any capacity, or any person controlling, controlled by or under common control with the issuer (1) has been convicted within five years preceding the filing of the letter of notification of any felony or misdemeanor involving the sale of any security or (2) is subject to an order, judgment or decree of any court of competent jurisdiction, entered within three years preceding the date of filing the letter of notification, enjoining it or him from engaging in or continuing any conduct or practice in connection with the sale of any security;

(h) Securities sold or delivered after sale in, or orders for which are accepted from a State while the right to offer or sell such securities in that State is prohibited, denied, or suspended by statute or by any regulatory body of the State for any reason other than the misconduct of a dealer in the securities.

Rule 222. Letter of Notification

(a) No securities shall be offered under this regulation until a letter of notification with respect thereto has been filed, as provided in paragraphs (b) and (c), by the issuer or by the person or persons by, on behalf of, or for the benefit of whom the offering is to be made, if other than the issuer. Every letter of notification shall contain the following information:

(1) The names and addresses of (A) the issuer; (B) all directors and officers of the issuer; (C) the person or persons by, on behalf of, or for the benefit of whom the offering is to be made; and (D) each principal underwriter.

(2) (A) The title of the securities proposed to be offered; (B) the principal amount of evidence of indebtedness or the number of shares or other units proposed to be offered; (C) the price per unit at which they are to be offered to the public; (D) the aggregate amount at which they are to be offered to the public; and (E) the aggregate amount at which all securities of the issuer have been offered to the public within one year by the person or persons filing the letter of notification. Where securities are to be offered "at the market" the information required by (C) and (D) shall be given upon the basis of the market price as established by bona fide sales made within a reasonable time prior to the date of filing the letter of notification.

(3) The approximate date of the proposed public offering.

(4) A list of the jurisdictions (States, Territories, the District of Columbia, or foreign countries) in which it is proposed to sell the securities. No securities shall be offered in any jurisdiction not mentioned in the original letter of notification until a supplementary letter stating the name of that jurisdiction has been filed. However, a statement that all or part of the offering is to be made by use of the facilities of a securities exchange (naming the exchange) shall suffice as to the securities to be so offered.

(5) If the securities are to be offered by, on behalf of, or for the benefit of the issuer, the purposes for which the net proceeds from the securities are to be used.

(b) An original and two copies of each letter of notification shall be filed with the regional office of the commission for the region in which the issuer's principal place of business is located or, if the issuer's principal place of business is located in the State of Maryland, Delaware, Virginia or West Virginia or in the District of Columbia, with the commission's Washington, D. C., field office. Form S-3b-1 may be used in supplying the information required to be set forth in the letter of notification.

(c) Any change in the matters stated in the letter of notification shall be set forth in a supplementary letter of notification, except that no supplementary letter of notification need be filed with respect to a change in the offering price of securities which are being offered at the market.

Rule 223. Written Communications, Advertisements and Radio Broadcasts

(a) Three copies of every written communication, advertisement or radio broadcast prepared or authorized by the issuer, any person controlling, controlled by, or under common control with, the issuer, or any principal underwriter of the securities to be offered, which is proposed to be used at the commencement of the public offering under this regulation or intended to be sent or delivered thereafter to more than ten persons shall be filed, prior to any use thereof, with the office of the commission with which the letter of notification is filed: PROVIDED, That there need not be filed copies of any communication which does no more than identify the securities, state the price thereof, and state by whom orders will be executed.

(NOTE.—The material filed pursuant to this rule is required to be filed solely for the information of the commission to aid it in the enforcement of Section 17 of the act, and not for the purpose of enabling the commission to cite any deficiency in the information contained therein. The failure of the commission at any time to take action upon any information filed pursuant to this rule does not indicate that the commission considers the information accurate, complete or not misleading.)

(b) Every written communication, advertisement or radio broadcast, a copy of which is required to be filed with the commission pursuant to this rule, shall contain a statement in substantially the following form:

> "Because these securities are believed to be exempt from registration, they have not been registered with the Securities and Exchange Commission; but such exemption, if available, does not indicate that the securities have been either approved or disapproved by the commission or that the commission has considered the accuracy or completeness of the statements in this communication."

In written communications and advertisements the statement shall be set forth on the first page in type as large as that used generally in the body thereof.

(c) No written communication, advertisement or radio broadcast, a copy of which is required to be filed with the commission pursuant to this rule, shall be used unless it contains the following information:

(1) The name of the person or persons by, on behalf of, or for benefit of whom the securities are being offered.

(2) The number of shares or other units being offered and the amount of underwriting discounts or commissions per unit or, if none, the per unit amount of expenses incurred or to be incurred in connection with the distribution of the securities (estimate if necessary).

(3) The aggregate amount of underwriting discounts and commissions or, if none, the aggregate amount of expenses incurred or to be incurred in connection with the distribution of the securities (estimate if necessary).

(4) If the securities are being offered by, on behalf of, or for the benefit of the issuer, the purposes for which the net proceeds from the securities are to be used.

Rule 224. Prohibition of Certain Representations

No written or oral communication used in connection with any offering under this regulation shall contain any language stating or implying that the commission has in any way passed upon the merits of, or given approval to, the securities or the terms of the offering, or has determined that the securities are exempt from registration, or has made any finding that the statements in any such communication are accurate or complete.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

Mr. Alfred L. Ransome, geological draftsman, resigned in December, to accept a position with the United States Bureau of Mines at Washington, D. C.

Mr. Eldridge D. Drew, formerly of Sacramento, has been appointed geological draftsman, vice Ransome resigned. He received his technical training at Sacramento Junior College.

New Publications

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, July 1940, being Chapter 3 of State Mineralogist's Report XXXVI. This chapter contains: "Economic Mineral Deposits of the Newberry and Ord Mountains, San Bernardino County"; "Geology of the Newberry and Ord Mountains, San Bernardino County", accompanied by a geologic map; "Notes on the Geology of a Portion of the Calico Mountains, San Bernardino County", accompanied by a geologic map; also a special article on "Study of Chrome Process Aided by Martin Dennis Company". The statistical branch contributed a summary and tabulation of the 1939 mineral production of California by substances and by counties. A list of new mineral specimens added to the museum exhibits is shown; followed by a list of corrections and additions to Bulletin 113, "Minerals of California".

COMMERCIAL MINERAL NOTES (Nos. 211, 212, 213), November, December, 1940, and January, 1941, respectively. These 'Notes' contain the lists of 'mineral deposits wanted' and 'mineral deposits for sale', issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology'. As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to five pages in recent months.

Mail and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum

HENRY H. SYMONS, Statistician and Curator

STATISTICS

California Mineral Production for 1940

The total value of the mineral production of California for the year 1940, just closed, is conservatively estimated by the Statistical Section to be $343,536,000. This is partly detailed in the tabulation below, but as there are more than 55 mineral substances on California's commercial list, figures on the most important items only are available at this early date. The production report forms are being mailed to the operators in all mineral lines, and the detailed and completed report will be compiled and published later.

The estimated total of $343,536,000 is a decrease of approximately $8,926,000 from the 1939 total value. The principal increases in values over those of the previous year were shown by cement, tungsten, copper, quicksilver, and the industrial group and saline group. Important minerals to register decreased values were petroleum, silver, miscellaneous stone, and brick.

Petroleum output showed a decrease of about 100,000 barrels in amount and a decrease in value of about 7 per cent from that of the previous year. The estimated quantity of crude oil was 224,167,000 barrels for 1940. There was a marked decrease in the price paid to producers by the refineries starting in February. There was a slight increase in the amount and value of natural gas utilized compared with 1939.

Receipts of the mint and smelters showed the output of gold about the same as in 1939. The State's yield of copper, lead, and zinc showed marked increases, also did those of the strategic metals quicksilver and tungsten and, in a smaller way, antimony, chromite, and manganese. Silver was the only important metal to show a decrease in annual yield. The output of quicksilver, silver, tungsten, and copper all passed the million dollar mark as well as gold.

Of the structural group, cement showed an increase in both amount and value over that of 1939, and more than enough to offset decreased annual values registered by miscellaneous stone and brick and hollow building tile. Building permits in 51 principal cities of the State increased 14 per cent and large public construction was less than in 1939. The increased cement demand was accounted for by out-of-state shipments. Stimulated demands and other conditions indicate the miscellaneous industrial materials and saline groups will show increase in their total values in 1940.

The estimated values and quantities for 1940 are as follows:

$ 50,000,000	(1,429,000 fine ounces) Gold.
1,589,000	(2,235,000 fine ounces) Silver.
1,520,000	(13,366,000 pounds) Copper.
2,970,000	(18,000 flasks) Quicksilver.
1,700,000	Tungsten Ore.
400,000	Other metals, including chromite, lead manganese ore, iron ore, platinum, antimony, zinc, etc.
210,720,000	(224,167,000 barrels) Petroleum.
21,647,000	(342,516,000 M. cu. ft.) Natural Gas.
18,400,000	(14,110,000 barrels) Cement.
10,000,000	Crushed rock, sand, and gravel.
2,800,000	Brick and hollow building tile.
1,800,000	Other structural materials, including bituminous rock, granite, lime, magnesite, marble, sandstone, and slate.
6,000,000	Miscellaneous industrial materials.
14,000,000	Salines including borates, potash, iodine, shale, soda, and others.
$343,536,000	Total value.

Museum

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

21025 CALCAREOUS SINTER or Geyserite.
Locality: Mammoth Terraces, Yellowstone National Park, Wyo.
Donor: B. Collins. August, 1940. In Case 505.

21026 METACINNABAR, HgS, black; with minor associated cinnabar and marcasite.
Locality: Mt. Diablo Quicksilver Mine, Contra Costa County, California.
Donor: Phil Cox. September, 1940. In Case 106.

21027 ENARGITE, Cu_3AsS_4, a copper sulpharsenate; this is one of the rare crystallized specimens found in California.
Locality: Morning Star Mine, Alpine County, California: 337-ft. level.
Donor: George L. Gary. September, 1940. In Case 111.

21028 OPAL from Queretero, Mexico.
Donor: Dr. Geo. D. Scott. September, 1940. In Case 616.

21029 Precious SERPENTINE.
Locality: Scott Ranch, Little Sulphur Creek, north of Healdsburg, Sonoma County, California.
Donor: Dr. Geo. D. Scott. September, 1940. In Case 616.

21030 Sandstone showing gastropod fossil.
Locality: Wilcox Ridge, opposite Athabasca Glacier, Columbia Ice Fields, Alberta, Canada.
Donor: B. Collins. September, 1940. In Case 505.

21031 BIMENTITE, $H_{10}Mn_8Si_7 0_{27}$, a hydrous manganese silicate (dark streaks) and Rhodochrosite (pink).
Locality: Ladd Mine, Corral Hollow, Alameda County, California.
Donor: Walter W. Bradley. October, 1940. In Case 140.

21032 RHODOCHROSITE, $MnCO_3$ (pink).
Locality: Ladd Mine, Corral Hollow, Alameda County, California.
Donor: Walter W. Bradley. October, 1940. In Case 201.

21033 PUMICE.
Locality: Near Benton, Mono County, California.
Donor: W. D. Field. October, 1940. In Case 217.

21034 MANGANESE OXIDE, 54.6% Mn, 2.8% Fe.
Locality: Lake County, California.
Donor: H. B. Turner. October, 1940. In Case 212.

21035 KAMMERERITE (peach blossom red), UVAROVITE (green) on CHROMITE (black), and SERPENTINE.
Locality: Clear Creek, New Idria District, San Benito County, California.
Donor: John T. Thorndyke. December, 1940. In Case 137.

21036 CHIASTOLITE, variety of Andalusite—large crystals.
Locality: Dalton Station, Madera County, California.
Donor: C. A. Noran. December, 1940. In Case 131.

21037 PSILOMELANE, an impure manganese oxide.
Locality: Rio Grande Valley, Hot Springs District, New Mexico.
Donor: John M. Nicol. December, 1940. In Case 119.

21038 PYRRHOTITE Crystal, Fe_nS_{n+1}.
Locality: Bluebell Mine, Kootenay Lake, B. C.
Loaned by B. L. Eastman. December, 1940. In Case 107.

21039 GRATONITE, $Pb_9As_4S_{15}$.
Locality: Cerro de Pasco, Peru.
Donor: George W. Rust. December, 1940. In Case 111.

21040 PYROLUSITE on CALCITE.
Locality: Jackson County, Oregon.
Donor: Hugh C. Ingle. October, 1940. In Case 240.

21041 ARAGONITE, psuedohexagonal caused by successive twining.
From the State of Texas.
Donor: K. G. Estey. December, 1940. In Case 121.

LABORATORY

George L. Gary, Mineral Technologist

Since 1866 many lists have been published showing localities of California minerals. The last one, "Minerals of California," by Adolph Pabst, was published in 1938 by the Division of Mines as Bulletin No. 113.

It is the intention of the Division of Mines to publish in the quarterly new localities for minerals that are received by the laboratory for determination. So that this information may be accurate, it is requested that all specimens submitted for classification be accompanied by a letter giving the exact location where the material was found.

Corrections will also be noted as well as additions when called to our attention.

CORRECTIONS AND ADDITIONS TO BULLETIN 113

96. Correction, Bulletin No. 113, index page 343, Proustite page number should be 81.
97. **Kyanite,** an aluminum silicate was reported from the Golden Charlotte mine, west of Perris, Riverside County.
98. **Pyrophyllite,** an aluminum silicate was reported from 7 miles west of Shoshone, near Sheephead Pass, Inyo County.
99. **Nahcolite** (sodium bicarbonate) occurs in various forms of aggregated crystals from cores taken at Searles Lake, San Bernardino County.
100. **Greenockite,** a cadmium sulfide was found as thin coatings on quartz colored by oxides of iron on San Bernardino Mountain, Sec. 31, T. 1 N., R 1 E., S. B. M., San Bernardino County.
101. Correction, Bulletin No. 113, page 61, Mono County, Xanthocroite should be xanthochroite.
102. Correction, Bulletin No. 113, Insert Andularia in index.
103. **Pyrostilpnite,** a silver-antimony sulfide has been found in the California Rand mine, in the Randsburg district, California.

LIBRARY

John C. O'Brien, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of federal and state governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and state maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the state are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE SPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Geological Survey:

Bulletin 922 H, Tungsten, Deposits of Atolia District, San Bernardino County and Kern County.
922 K, Antimony Deposits of the Wildrose Canyon Area, Inyo County.

Topographic Maps

Castaic Quadrangle, Los Angeles County
Chatsworth Quadrangle, Los Angeles County
Dome Rock Mountains Quadrangle, Arizona and California
Healdsburg Quadrangle, Sonoma County
LaVerne Quadrangle, Los Angeles County
Trail Canyon Quadrangle, Los Angeles County
Valyermo Quadrangle, Los Angeles County

Reports of Investigation:
3539 Shrinkage of Coke.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State.

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries, Portland.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign.

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions.

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers, New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Acadamy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File.

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Conservationist, Sacramento, California.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.

Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining World, Seattle.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Cheney, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers.

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Courier Free Press, Redding, California.
Daily Commercial News, San Francisco, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Humboldt Beacon, Humboldt.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mining Press, Reno, Nevada.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.

Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Owens Valley Progress-Citizen, Lone Pine, California.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
Randsburg Times, Randsburg, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

Write for latest revised price list.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price (including postage and sales tax)
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks Price $0.75, sales tax $0.02	$0.77
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr. Price $0.75, sales tax $0.02	.77
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr. Price $1.50, sales tax $0.05	1.55
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, XIV Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper Price $0.75, sales tax $0.02	.77
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----
Chapters of the State Mineralogist's Report, XV Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper Price $0.75, sales tax $0.02	.77

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.	Price (including postage and sales tax)
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper Price $0.75, sales tax $0.02	$0.77
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper Price $0.75, sales tax $0.02	.77
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper Price $1.00, sales tax $0.03	1.03
Mines and Mineral Resources of Plumas County, 188 pp., paper Price $0.75, sales tax $0.02	.77
Mines and Mineral Resources of Sierra County, 144 pp., paper Price $0.75, sales tax $0.02	.77
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth Price $2.50, sales tax $0.08	2.58
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, **March, **April, May, June, July, August, September, October, November, December, 1922 Price $0.40, sales tax $0.01	.41
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 Price $0.40, sales tax $0.01	.41
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy Price $0.40, sales tax $0.01	.41
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties Price $0.40, sales tax $0.01	.41
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties Price $0.40, sales tax $0.01	.41
**July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	----
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties Price $0.40, sales tax $0.01	.41
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Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
RICHARD SACHSE, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

Vol. 37 April, 1941 No. 2

CALIFORNIA JOURNAL
OF
MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXVII

STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
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99355

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TABLE OF CONTENTS

Page
DISTRICT REPORTS OF MINING ENGINEERS 201
  Sacramento Field District 201
  San Francisco Field District 201
  Los Angeles Field District 201
  Redding Field District 201

GEOLOGIC BRANCH 202
  Current Notes 202
  Geologic Progress of the California State Division of Mines, 1930 to 1940 205
  California Earthquakes of the Mission Period, 1769-1838, by Robert F. Heizer 219
  Occurrence of Scheelite in Idaho-Maryland Mines at Grass Valley, California, by Rollin Farmin 224
  Tungsten Resources of California, by John F. Partridge, Jr. 225

SPECIAL ARTICLES 327
  Dragline Dredging in Siskiyou County 328
  Marketing Talc, Pyrophyllite and Ground Soapstone, by Bertrand L. Johnson 332
  Manganese 342
  Magnesite 345

ADMINISTRATIVE 348

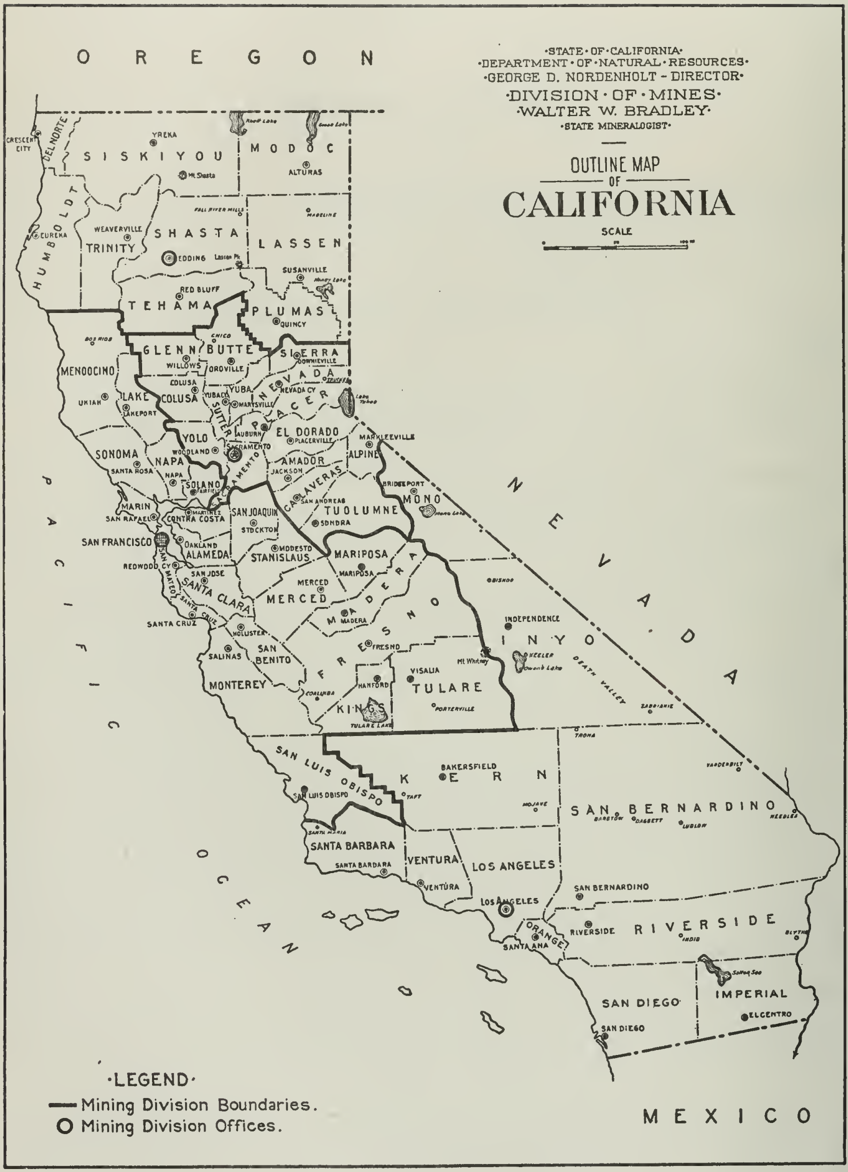
MINERALS AND STATISTICS 349
  Statistics 349
  Museum 363
  Laboratory 365

LIBRARY 366

PRODUCERS AND CONSUMERS 371

EMPLOYMENT SERVICE 372

PUBLICATIONS I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OREGON
NEVADA
MEXICO
PACIFIC OCEAN
SISKIYOU
MODOC
DEL NORTE
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
LAKE
COLUSA
SUTTER
YUBA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
SOLANO
SACRAMENTO
AMADOR
ALPINE
MARIN
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SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
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ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
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SAN BENITO
FRESNO
INYO
MONTEREY
KINGS
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SAN LUIS OBISPO
KERN
SAN BERNARDINO
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VENTURA
LOS ANGELES
ORANGE
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SAN DIEGO
IMPERIAL
CRESCENT CITY
YREKA
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BISHOP
HOLLISTER
MADERA
INDEPENDENCE
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FRESNO
KEELER
Owens Lake
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DEATH VALLEY
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PORTERVILLE
TULARE LAKE
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RIVERSIDE
INDIO
BLYTHE
SANTA ANA
Salton Sea
SAN DIEGO
EL CENTRO
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).
3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

SACRAMENTO FIELD DISTRICT

C. A. LOGAN, Mining Engineer

On account of unfinished field work, there is no report from the Sacramento Field District in this issue.

SAN FRANCISCO FIELD DISTRICT

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field District are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

On account of unfinished field work, there is no report from the Los Angeles Field District in this issue.

REDDING FIELD DISTRICT

CHAS. VOLNEY AVERILL, Mining Engineer

Under Special Articles, there is a report on Dragline Dredging in Siskiyou County, by Mr. Charles Volney Averill.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

In Memoriam

All persons interested in the mineral industry, geology, and related sciences will be shocked to learn of the death of Dr. Solon Shedd, who so generously gave his time, effort, and personal interest in the preparation of our "Bibliography of the Geology and Mineral Resources of California." He passed away at the age of 80, on March 4, 1941, leaving a substantial gift for the building up of the Branner Memorial Geological Library of Stanford University, which has been so helpful not only to the faculty and students, but to our own department and to hundreds of geologists and engineers not connected with the University.

Mr. LeVern W. Cutler, who took over the care of the library after the recent retirement of Dr. Shedd, will continue the bibliographic work Dr. Shedd started. The bibliography is an exhaustive list of references, well cataloged, and of the utmost value to research. Our Bulletin 104 carries the work from the beginning of publications on California to December 31, 1930. Bulletin 115 is a continuation of the compilation to the end of 1936. The continued bibliography for 1937 appears as a part of the California Journal of Mines and Geology, vol. 35, no. 3, July 1939. Work is now being done by Mr. Cutler to list the more recent publications, and to annotate as many of them as possible.

The bibliographic work so carefully started and carried forward by Dr. Shedd is a lasting foundation for all of our reports; it has proved especially valuable in the preparation of the statewide treatises on economic minerals which the Geologic Branch is issuing from time to time.

In This Issue

In the following paper "Geological Progress of the California State Division of Mines, 1930 to 1940," we have attempted to take stock of the reports on geology that we have been instrumental in issuing during the past eleven years. This list shows that nearly all phases of the science have been given consideration.

A short paper on the "Earthquakes of the Mission Period, 1769-1838," by Robert F. Heizer, appears in this issue of the Journal. It shows that strong earthquakes are the usual thing to be expected in the coastal region of California. They even welcomed the earliest explorers, over 100 years ago.

The timely statewide report on "Tungsten Resources of California," by John F. Partridge, Jr., which is the major report of this issue of the Journal, represents the result of cooperation with the

Mining Department of Stanford University, under whose supervision the work was done.

Forthcoming Publication

Part Two, ''Geology of California and the Occurrence of Oil and Gas,'' of Bulletin 118, ''Geologic Formations and Economic Development of the Oil and Gas Fields of California,'' will soon be ready for distribution. It contains 195 pages, includes about 100 illustrations, and 5 large plates.

CONTENTS OF PART TWO, BULLETIN 118

Chapter IV

Introduction to the Geology

Geomorphic provinces of California, by Olaf P. Jenkins

Salient geologic events in California and their relationship to mineral deposition, by Olaf P. Jenkins

Position of the California oil fields as related to geologic structure, by Ralph D. Reed

Chapter V

Geologic History and Structure

California's record in the geologic history of the world, by Ralph D. Reed

Geologic history and structure of the central Coast Ranges of California, by N. L. Taliaferro

Chapter VI

Paleontology and Stratigraphy

Characteristic fossils of California, by G. Dallas Hanna and Leo George Hertlein

Synopsis of the later Mesozoic in California, by Frank M. Anderson

Notes on California Tertiary correlation, by Bruce L. Clark

Eocene foraminiferal correlations in California, by Boris Laiming

Sequence of Oligocene formations of California, by Lesh C. Forrest

Correlation chart of the Miocene of California, by Robert M. Kleinpell; Introduction by William D. Kleinpell

Pliocene correlation chart, by U. S. Grant IV and Leo George Hertlein

The Pleistocene in California, by J. E. Eaton

Chapter VII

Occurrence of Oil

Stratigraphic formations of the producing zones of the Los Angeles Basin oil fields, by Stanley G. Wissler

Correlation of the oil fields of the Santa Maria district, by Stanley G. Wissler and Frank E. Dreyer

Correlation of oil field formations on east side San Joaquin Valley, by Glenn C. Ferguson

Correlation of oil field formations on the west side of San Joaquin Valley, by Paul P. Goudkoff

Origin, migration, and accumulation of oil in California, by Harold W. Hoots

GEOLOGICAL PROGRESS OF THE CALIFORNIA STATE DIVISION OF MINES, 1930 to 1940

By Olaf P. Jenkins, Chief Geologist

OUTLINE OF REPORT

Page
INTRODUCTION 206
NUMBER OF DIFFERENT REPORTS 207
AFFILIATION OF CONTRIBUTORS 208
CONTRIBUTING AUTHORS 209
LIST OF PUBLICATIONS, 1930 TO 1940, INCLUSIVE 209
  Exhaustive bibliographies 209
    State-wide 209
    Special subjects 210
  History of geology 210
  Regional areal geology 210
  Specific areas—geology and mineral resources 210
  Geology of specific mines 212
  Stratigraphy and paleontology 212
  Marine sedimentation 213
  Stream deposition 213
    Placer deposits 213
    Glacial deposits 213
  Physiographic geology 214
    Lakes 214
    Provinces of California 214
  Mineralogy 214
  Economic minerals 214
    General economic geology 214
    State-wide economic mineral map 214
    Metallic minerals 215
    Non-metallic minerals 215
    Oil and gas 215
  Engineering geology 216
  Technique in geology 216
  Progress reports and notes 216
CONCLUSIONS 217

INTRODUCTION

Since the establishment of the Geologic Branch of the California State Division of Mines in July, 1929, a long list of reports and maps on geology has been issued, touching upon nearly every phase of that subject, and every province in the State. In many cases, these reports represent contributions by persons not regular members of the staff, whose work is unquestionably authoritative and is based on both field and laboratory studies.

The Geologic Branch has endeavored to assemble these reports in a systematic manner, to verify them in the field, and to edit them in accordance with proper technical practice. Many valuable papers have been ''unfrozen'' from their previous unpublished, and thus unavailable form.

The geological investigations have included regional and areal mapping; historical, stratigraphic, and structural geology; physiography and the processes involved in rock and mineral formation; description and distribution of minerals; economic geology, including metals, non-metals, and petroleum; and many other phases of the subject, such as engineering geology, ground water, and geologic technique. Beside these investigations, the Geologic Branch has issued exhaustive bibliographies and statewide compilations, such as the Geologic Map of California, and the State map of quicksilver deposits. All this has required both field and library study and the preparation of a large number of maps and charts.

The program of the Geologic Branch is in close cooperation with the work of the Division's District Mining Engineers, who are continually taking detailed inventories of the State's mineral resources and mining development. This has made it possible to supplement the geological articles on specific areas by economic reports on the mining properties in those areas.

Since geology is the fundamental science of mineral deposits, this coordination of the geological studies with the economic record is of inestimable value for the intelligent understanding of the practical problems involved.

In the study of oil and gas resources, geology is of particular importance, for it is the controlling factor in the progress of the industry. In the non-metallic mineral industries, in which there are many untouched new fields for investigation, geology is especially needed to further exploration and development of these vast mineral resources of the State.

As a matter of fact, the scope of the usefulness of the various studies in the geology of California could be greatly enlarged by further application of them to many engineering enterprises, such as highway engineering, location of engineering construction, prevention of earthquake and landslide disasters, and development of groundwater resources.

The educational value of geology has no limits. Mineral collectors find much benefit in knowing the geologic background of their study.

The enjoyment of scenic excursions, coastal and mountain parks, is always increased by the more intimate knowledge of this natural science.

To limit geology to use only in the mineral industry would be short-sighted indeed; for the full utilization of California's natural resources would then be sadly restricted. To extend its usefulness into the many related fields of engineering, science, and recreation would mean closer cooperation with other State divisions and departments, and would result in a more intelligent coordination of mutual interests.

The future of geologic work in California seems boundless. Its horizon widens as industries increase, and its usefulness expands with every broadening point of view.

The following list of reports, arranged according to subject matter, shows the field of activity of the Geologic Branch during the years 1930 to 1940, inclusive, and indicates to what extent cooperation has been received.

NUMBER OF DIFFERENT REPORTS[1]

Subject	Number
Exhaustive bibliographies on geology and mineral resources	5
History of geology	1
Regional areal geology	4
Geology of specific areas (including economic minerals)	26
Geology of specific mines	2
Stratigraphy and paleontology	8
Marine sedimentation	2
Stream deposition (placers)	4
Glacial deposits	1
Physiographic geology	2
Mineralogy	6
Geology of economic minerals (not included above)	13
Geology of oil and gas (not included above)	11
Engineering geology	3
Technique in geology	7
Total number of different reports on geology of California, for which the Geologic Branch was responsible or in part responsible	95

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[1] Not including papers in preparation or in press.

AFFILIATION OF CONTRIBUTORS

The following is a list of institutions, etc., with which the contributing authors were affiliated while preparing their reports. This list does not include over 200 contributors to the Geologic Map of California, over 100 contributors to Parts Two, Three, and Four of Bulletin 118, or contributors of other papers in preparation or in press.

University of California	15
University of California at Los Angeles	4
Stanford University	7
University of Southern California	3
California Institute of Technology	7
Pomona	1
Cornell University	1
Harvard University	1
Massachusetts Institute of Technology	1
California Academy of Sciences	4
Chabot Observatory	1
Scripps Institute at La Jolla	1
U. S. Geological Survey	3
U. S. Bureau of Mines	1
U. S. Forest Service	1
U. S. Coast and Geodetic Survey	1
Oil Umpire's Office	2
Oil Producers Agency	1
Company Employees and Consultants	19

CONTRIBUTING AUTHORS

The following is an alphabetical list of names of contributing authors (73 in number), not including regular members of the staff of the Division of Mines. This list does not include more than 200 contributors to the Geologic Map of California, or more than 100 other contributors of papers in press or in preparation.

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J. Clark Sutherland
J. A. Taff
Lester C. Uren
F. E. Vaughan
M. Vonsen
Wm. R. Wardner, Jr.
Robert W. Webb
W. Q. Wright, Jr.

LIST OF PUBLICATIONS, 1930 TO 1940, INCLUSIVE

Exhaustive Bibliographies

State-Wide

References to practically all publications on the geology and mineral resources of California to the end of 1937 have been compiled by the Geologic Branch, and may be found in the following publications, each of which is well indexed:

Bibliography of the geology and mineral resources of California to December 31, 1930, by Solon Shedd. Cal. St. Div. Mines, Bull. 104, 376 pp., 1932. *Includes also* "Pioneers in the geology of California", by Frank M. Anderson, pp. 1-24, pls. I-XIV.

Bibliography of the geology and mineral resources of California for the years 1931 to 1936, inclusive, by Solon Shedd. Cal. St. Div. Mines, Bull. 115, 125 pp., 1937.

Bibliography of the geology and mineral resources of California for the year 1937, by Solon Shedd. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 3, July 1939, pp. 275-307.

Special Subjects

In addition to these general, State-wide bibliographies, the Geologic Branch has prepared complete lists of references on special subjects, for example:

Bibliography of California placers and related geological subjects, *accompanying the report* "New technique applicable to the study of placers", by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 31, no. 2, April 1935, pp. 201-210.

Bibliography of the quicksilver resources of California, *accompanying the report* "Quicksilver resources of California", by Alfred L. Ransome and John L. Kellogg. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 4, October 1939, pp. 477-486.

History of Geology

Pioneers in the geology of California, by Frank M. Anderson. Cal. St. Div. Mines, Bull. 104, 1932, pp. 1-24, pls. I-XIV.

Regional Areal Geology

As a forerunner of the Geologic Map of California, the Geologic Branch issued a geologic map, and report to accompany it, on the northern Sierra Nevada.

Report accompanying geologic map of northern Sierra Nevada, by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 28, nos. 3 and 4, July and October 1932, pp. 279-298, 8 figs., 1 geologic map, with red overprint *showing* Tertiary river channels and Mother Lode belt. *Reprinted,* with slight change in red overprint, and with report printed on back of map.

The following report represents cooperation of the Geologic Branch with an international organization:

Middle California and western Nevada, prepared under the direction of Olaf P. Jenkins, Int. G Cong., Guide Book 16, Exc. C-1, 116 pp., 16 figs., 18 pls., 1933. Written by 11 authors: Andrew C. Lawson, Olaf P. Jenkins, William Morris Davis, Bruce L. Clark, F. E. Matthes, Ernst Cloos, Adolph Knopf, Walter W. Bradley, Eliot Blackwelder, J. C. Jones, Vincent P. Gianella.

A systematic and accurately made assemblage of geologic map data, both unpublished and published, is represented by the large, six-sheet, colored map of the State.

Geologic map of California, first edition, scale 1:500,000, by Olaf P. Jenkins. Cal. St. Div. Mines, 1938. *Includes* marginal maps and charts: legend, source data, time scale, geomorphic map, glacial map, and other index maps and explanatory charts.

Source data of the geologic map of California, January 1937, by Olaf P. Jenkins, Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 33, no. 1, January 1937, pp. 9-37, 1 source map (pl. I).

Blank areas of the geologic map of California, by Olaf P. Jenkins, (*abst*) G Soc. Am., Pr. 1936, pp. 336-337, 1937.

Specific Areas—Geology and Mineral Resources

Detailed geologic maps with accompanying reports on certain areas, ordinarily topographic quadrangles, have been published from time to time by the Geologic Branch. Such work is invaluable as a basis for later economic development of the mineral resources. These reports often contain a chapter on economic geology, but if not, one of the Division's engineers makes a special inventory of the mines of the area to supplement it. The following is a list of such reports prepared under the direction of the Geologic Branch:

Preliminary report on the geology of southwestern Mono County, California, by Evans B. Mayo. Cal. St. Div. Mines, Mining in Calif., vol. 26, no. 4, October 1930, pp. 475-482, 3 illus.

Areal geology of the Shasta quadrangle, by the Geological Department of the Southern Pacific Company, *accompanying* "Preliminary report on economic geology of the Shasta quadrangle," by Charles Volney Averill. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 1, January 1931, pp. 2-65, 31 illus.

Preliminary report of the geology of Santa Cruz Island, Santa Barbara County, California, by William W. Rand. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 2, April 1931, pp. 214-219, 1 map.

Geology of San Jacinto quadrangle south of San Gorgonio Pass, California, by Donald McCoy Fraser. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 4, October 1931, pp. 494-540, 23 figs., 1 geologic map. The geologic map was reprinted with overprint in red *showing* "Location of economic mineral deposits", by R. J. Sampson, Cal. St. Div. Mines, Mining in Calif., vol. 28, no. 1, January 1932, pl. I.

Geology of a part of the Panamint Range, California, by F. M. Murphy. Cal. St. Div. Mines, Mining in Calif., vol. 28, nos. 3 and 4, July and October 1932, pp. 329-356, 12 figs., 1 geologic map (pl. IV). *Supplemented by* report on mineral resources by R. J. Sampson, pp. 357-376.

Geologic formations of the Redding-Weaverville districts, northern California, by Norman E. A. Hinds. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 1 and 2, January and April 1933, pp. 76-122, 1 fig., 1 geologic map (pl. III) with red overprint *showing* location of gold mines, *to accompany* a report on the gold mines of the region by Chas. V. Averill.

Economic geology of portions of Del Norte and Siskiyou Counties, northwesternmost California, by John H. Maxson. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 1 and 2, January and April 1933, pp. 123-160, 26 figs., 1 geologic map (pl. IV).

Geology and mineral resources of northwestern Madera County, California, by Homer D. Erwin. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 30, no. 1, January 1934, pp. 7-78, 41 figs., 1 geologic map (pl. I).

Geology and mineral deposits of Laurel and Convict Basins, southwestern Mono County, California, by Evans B. Mayo. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 30, no. 1, January 1934, pp. 79-88, 4 figs., 1 geologic map (pl II), 1 claim map (pl. III).

Geology and mineral deposits of the Julian district, San Diego County, California, by Maurice Donnelly. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 30, no. 4, October 1934, pp. 331-370, 13 figs., 1 geologic map (pl. IV).

Geology and mineral deposits of the Elizabeth Lake quadrangle, California, by Edward C. Simpson. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 30, no. 4, October 1934, pp. 371-415, 15 figs., 1 geologic map (pl. V).

A geologic section across the southern Peninsular Range of California, by William J. Miller. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 31, no. 2, April 1935, pp. 115-142, 8 figs., 1 geologic map (pl. II).

Geology of a portion of the Perris block, southern California, by Paul H. Dudley. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 31, no. 4, October 1935, pp. 487-506, 10 figs., 1 geologic map (pl. VIII). *Accompanied by* a mineral resources report by R. J. Simpson, pp. 507-521.

Map of Plumas County, showing areal geology and locations of principal mines, accompanying report by Chas. V. Averill. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 33, no. 2, April 1937, pp. 79-143.

Geology and mineral deposits of the western San Gabriel Mountains, Los Angeles County, by Gordon B. Oakeshott. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 33, no. 3, July 1937, pp. 215-249, 7 figs., 1 geologic map (pl. III).

Sierra Nevada pluton and crustal movement, by Evans B. Mayo. Jour. Geology, vol. 48, 1937, pp. 169-192, 6 figs. (This reference is included because field expenses were supplied by the Geologic Branch of the California State Division of Mines for part of the early work upon which this investigation was first based.)

Geology of the central Santa Monica Mountains, Los Angeles County, by E. K. Soper. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 2, April 1938, pp. 131-180, 15 figs., 1 geologic map (pl. I).

Geology and ore deposits of the Darwin silver-lead district, Inyo County, California, by Vincent C. Kelley. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 4, October 1938, pp. 503-562, 31 figs., 3 geologic maps (pls. V, VI, VII).

Geology and oil possibilities of southwestern San Diego County, by Leo George Hertlein and U. S. Grant. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 1, January 1939, pp. 57-78, 8 figs., including geologic map.

Tertiary formations of northern Sacramento Valley, California, by Charles A. Anderson and R. Dana Russell. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 3, July 1939, pp. 219-253, 14 figs., 1 geologic map (pl. III), *including* "List of wells drilled by oil and gas companies", by Olaf P. Jenkins.

Geology and oil possibilities of Caliente Range, Cuyama Valley, and Carrizo Plain, California, by J. E. Eaton. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 3, July 1935, pp. 255-274, 5 figs., 1 geologic map (pl. IV).

Geology of the Lucia quadrangle, California, by Parry Reiche. Cal. Univ., Bull. Dp. Geological Sciences, vol. 24, no. 7, 1937, pp. 115-168, 11 figs., 1 geological map. (Though this work is published by the University of California, a part of the field expenses were paid by the Geologic Branch, California State Division of Mines.)

Geology of the Newberry and Ord Mountains, San Bernardino County, California, by Dion L. Gardner. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 36, no. 3, July 1940, pp. 257-292, 9 figs., 1 geologic map (pl. II).

Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California, by Homer D. Erwin and Dion L. Gardner. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 36, no. 3, July 1940, pp. 293-304, 1 geologic map (pl. III).

General geology and ores of the Blind Spring Hill mining district, Mono County, by Alfred L. Ransome. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 36, no. 2, April 1940, pp. 160-197, 27 figs., including geologic map.

Descriptive geology of the Kernville quadrangle, California, by William J. Miller and Robert W. Webb. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 36, no. 4, October 1940, pp. 243-262, 31 figs., 1 geologic map, showing locations of mineral deposits (pl. II). *Supplemented by* a report on the economic mineral resources by W. B. Tucker and R. J. Sampson, pp. 322-332.)

Geology of Specific Mines

One of the most-needed types of geologic work consists of detailed underground mapping. This is generally done under the mine management, and is seldom released for publication.

Soon after the Geologic Branch was established, it had a small appropriation for special work. A part of this was spent in cooperation with the United States Geological Survey in furnishing the services of Robert L. Loofbourow to work as assistant to W. D. Johnston, Jr., in the mines of Grass Valley. The results of the work were recently published by the Federal Government.

The gold quartz veins of Grass Valley, California, by W. D. Johnston, Jr. U. S. Geological Survey, Prof. Paper 194, 1940, 101 pp., 69 figs., 39 pls.

In the October 1940 issue of the California Journal of Mines and Geology, John W. Prout has contributed a report based on field work done in the Big Blue group of mines.

Geology of the Big Blue group of mines, Kernville, California, by John W. Prout, Jr. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 36, no. 4, October 1940, pp. 379-442, 22 figs., 1 geologic map (pl. III).

Stratigraphy and Paleontology

Geologic reports on specific areas or regions generally discuss stratigraphy, and sometimes touch upon paleontology. In addition, certain reports have been published by the Geologic Branch that deal entirely with these subjects:

Upper Cretaceous (Chico) deposits in Siskiyou County, California, by F. M. Anderson. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 1, January 1931, pp. 11-14, 2 illus.

Stratigraphic significance of the Kreyenhagen shale of California, by Olaf P. Jenkins. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 2, April 1931, pp. 141-186, 10 figs., 1 pl.

Diatoms and silicoflagellates of the Kreyenhagen shale, by G. D. Hanna. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 2, April 1931, pp. 187-201, pls. A-E.

Foraminifera of the Kreyenhagen shale, by C. C. Church. Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 2, April 1931, pp. 202-213, pls. A-C.

Notes on occurrence and age of fossil plants found in the auriferous gravels of Sierra Nevada, by Ralph W. Chaney. Cal. St. Div. Mines, Mining in Calif., vol. 28, nos. 3 and 4, July and October 1932, pp. 229-302, 2 figs. *Reprinted* on back of "Geologic map of northern Sierra Nevada", by Olaf P. Jenkins, 1932.

Jurassic and Cretaceous divisions in the Knoxville-Shasta succession of California, by Frank M. Anderson. Cal. St. Div. Mines, Mining in Calif., vol. 28, nos. 3 and 4, July and October 1932, pp. 311-328, 5 figs., 1 geologic section (pl. III).

Notes on the Cambrian rocks of the eastern Mohave Desert, California, by John C. Hazzard, *with* a paleontological report by Colin H. Crickmay. Cal. Univ., Dept. Geol. Sci., Bull. 23, no. 2, 1933, pp. 57-80, pl. 1, 1 fig., 1 map. (Although this work was published by the University of California, the field work was made possible through funds supplied by the Geologic Branch of the California State Division of Mines.)

Paleozoic sections in the Nopah and Resting Springs Mountains, Inyo County, California, by John C. Hazzard. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 33, no. 4, October 1937, pp. 273-339, 15 figs. *Introduced by* a statement by Levi F. Noble, pp. 271-272. A report on the mineral resources of the region, by W. B. Tucker and R. J. Sampson, supplements this geological paper, pp. 264-270.

Marine Sedimentation

Knowledge of processes in geology that are going on today gives a better understanding of what went on in the past. A purely scientific study of the actual formation of marine sediments was presented by the Geologic Branch and has received much favorable comment from oil geologists. Of interest in this field is also a paper on the peculiar submarine topography off the coast, and the processes which were involved in producing deep under-sea canyons.

Sediments of Monterey Bay, California, by E. Wayne Galliher. Cal. St. Div. Mines, Mining in Calif., vol. 28, no. 2, January 1932, pp. 42-79, 17 figs., 1 lithologic map (pl. III).

Submarine canyons off the California coast, by Francis P. Shepard. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 3, July 1938, pp. 298-310, 9 figs.

Stream Deposition

Placer Deposits

The geologic features and processes of formation of gravel deposits containing gold accumulations have been studied and reported upon by the Geologic Branch:

Resurrection of early surfaces in the Sierra Nevada, a fundamental geologic process involved in placer gold deposition, by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 30, no. 1, January 1934, pp. 5-6, fig. 1.

Geologic features of the dry placers of the northern Mojave Desert, by Carlton D. Hulin. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 30, no. 4, October 1934, pp. 416-426, 2 illus.

New technique applicable to the study of placers, by Olaf P. Jenkins, Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 31, no. 2, April 1935, pp. 143-210, 35 figs., 1 geologic map (pl. III).

California's gold-bearing Tertiary channels, by Olaf P. Jenkins and W. Q. Wright, Jr. Eng. Mining Jour. 135, 1934, pp. 497-502.

Glacial Deposits

In the high Sierra Nevada there is an extensive and scenic area which was effected by the glaciers of the Pleistocene period. A brief report on the deposits of these glaciers and a map of the areal extent of glaciation have been published by the Geologic Branch:

Glacial and associated stream deposits of the Sierra Nevada, by Eliot Blackwelder. Cal. St. Div. Mines, Mining in Calif., vol. 28, nos. 3 and 4, July and October 1932, pp. 303-310, 5 figs., 1 map of the Pleistocene glaciers (pl. II); map *reprinted* as "Glacial Map of Sierra Nevada", with revisions by F. E. Matthes, 1937, in margin of Sheet V, Geologic Map of California, 1938, by Olaf P. Jenkins.

Physiographic Geology

Lakes

A comprehensive report on the principal lakes of California and their possible origin has been published by the Geologic Branch:

The lakes of California, by William Morris Davis. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 1 and 2, January and April 1933, pp. 175-236, 29 figs., 1 map of California lakes.

Provinces of California

The geomorphic or physiographic provinces of California are shown on a map, and their salient features described by the Geologic Branch:

Geomorphic map of California, by Olaf P. Jenkins. Cal. St. Div. Mines, Geologic Map of California, Sheet II, 1938.

Mineralogy

Under the direction of the Geologic Branch, the Division's bulletin on the minerals of California was revised and published. Occasional papers on the discovery of new minerals and new mineral occurrences are issued in the Journal.

Discovery of piedmontite in the Sierra Nevada, by Evans B. Mayo. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 1 and 2, January and April 1933, pp. 239-243, 3 figs.

Borax Lake, California, by M. Vonsen and G. D. Hanna. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 32, no. 1, January 1936, pp. 99-108, 5 figs.

Minerals of California, by Adolph Pabst. Cal. St. Div. Mines, Bull. 113, 1938, 344 pp.

Gem minerals of California, by Francis J. Sperisen. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 1, January 1938, pp. 34-78, 5 figs., 1 colored plate. (*Published under* "Special Articles.")

Mineral high-lights of California, by Walter W. Bradley. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 3, July 1938, pp. 292-297.

The giant Goose Lake meteorite from Modoc County, California, by Earle G. Linsley. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 3, July 1939, pp. 309-312, 3 figs. (including map of meteorites in California).

Economic Minerals

Several reports published by the Geologic Branch have had to do with the study of special economic minerals and mineral products. The plan is to issue a series of economic mineral maps, each map covering the entire State, and accompanied by a comprehensive report on each mineral.

General Economic Geology

Gold and petroleum in California, by Waldemar Lindgren. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 1, January 1938, pp. 27-32.

Strategic minerals in California, by Charles White Merrill. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 3, July 1938, pp. 283-291.

Where to look for new deposits of minerals. *In* "Current Notes", by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 4, October 1939, pp. 350-351.

Strategic problems of the mineral industry of California, by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 36, no. 4, October 1940, pp. 335-341.

State-Wide Economic Mineral Map

Outline geologic map of California, showing locations of quicksilver properties. *Prepared under the direction of* Olaf P. Jenkins. Economic Mineral Map of California No. 1, Quicksilver. Scale 1:1,000,000. Cal. St. Div. Mines, 1939.

Metallic Minerals

The geology of quicksilver ore deposits, by C. N. Schuette. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 33, no. 1, January 1937, pp. 38-50, 11 figs.

Quicksilver resources of California, by Alfred L. Ransome and John L. Kellogg. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 35, no. 3, October 1939, pp. 353-486, 26 figs., 2 tables.

Non-Metallic Minerals

Geology and physical properties of building stone from Carmel Valley, California, by E. Wayne Galliher. Cal. St. Div. Mines, Mining in Calif., vol. 28, no. 1, January 1932, pp. 14-41, 25 figs., 1 geologic map (pl. II).

Limestone deposits of the San Francisco region, by Edwin C. Eckel. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 3 and 4, July and October 1933, pp. 348-361, 1 fig., 1 geologic map. *Accompanied by* **Limestone weathering and plant associations of the San Francisco region,** by Junea W. Kelley, pp. 362-368. (*Published under* "Special Articles".)

Geological investigation of the clays of Riverside and Orange Counties, southern California, by J. Clark Sutherland. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 31, no. 1, January 1935, pp. 51-87, 23 figs., 1 location map (pl. I).

Geology, mining and processing of diatomite at Lompoc, Santa Barbara County, California, by Henry Mulryan. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 32, no. 2, April 1936, pp. 133-166, 23 photos, 1 index map. (*Published under* "Special Articles".)

Sulphur deposits of Inyo County, California, by Edward D. Lynton. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 4, October 1938, pp. 563-590, 14 figs.

California clay deposits—a geologic review, by Olaf P. Jenkins. Pac. Chem. and Metallurgical Ind., vol. 3, no. 3, March 1939, pp. 9-11, 1 fig.

Oil and Gas

To meet the ever-increasing need for a comprehensive treatise on the geology of the oil and gas industry of California, the Geologic Branch has embarked on the preparation of such a volume, the first part of which is already published. This bulletin has been issued in a large size (8½ x 11 inches) so as to accommodate the numerous maps and charts embodied in it. The treatise consists of a systematically prepared and arranged series of reports contributed by a large number (over 100) of outstanding authorities actually engaged in the work of the industry.

Geologic formations and economic development of the oil and gas fields of California, *prepared under the direction of* Olaf P. Jenkins. Cal. St. Div. Mines, Bull. 118, Pre-print of Part One, Development of the Industry, April 1940, pp. 1-80, 35 figs., 1 historical production chart (pl. I); Part Two, Geology of California and the Occurrence of Oil and Gas, *in press;* Part Three, Descriptions of Individual Oil and Gas Fields, *in preparation;* Part Four, Glossaries, Bibliography, and Index (to include also an economic oil and gas map of California), *in preparation.*

Part One consists of 11 individual reports, as follows:

Economics of the oil and gas industry, by J. R. Pemberton, pp. 3-14, figs. 1-2.

Taxation and its relation to development and production, by Granville S. Borden, pp. 15-16.

Historical production chart, by H. L. Scarborough, pl. I.

Stocks chart, by H. L. Scarborough, fig. 3.

Shipments chart, by H. L. Scarborough, fig. 4.

Significant statistics characteristic of crude oil production of California, by Wm. R. Wardner; tables: Los Angeles Basin, pp. 20-21; Coast and Transverse Ranges, pp. 22-23; San Joaquin Valley, pp. 24-25.

Analysis of California petroleum reserves and their relation to demand and curtailment, by Wm. R. Wardner, Jr., pp. 26-32, figs. 5-11.

Natural gas fields of California, by Roy M. Bauer and John F. Dodge, pp. 33-36, figs. 12-13.

Development of engineering technique and its effect upon exploration for oil and gas in California, by Lester C. Uren, pp. 39-62, figs. 14-27.

Mechanics of California reservoirs, by Stanley C. Herold, pp. 63-66, figs. 28-31.

Geophysical studies in California, by F. E. Vaughan, pp. 67-70, fig. 32.

Geochemical prospecting for petroleum, by E. E. Rosaire, pp. 71-72, fig. 33.

Aboriginal use of bitumen by the California Indians, by Robert F. Heizer, p. 74, fig. 34.

History of exploration and development of gas and oil in northern California, by Walter Stalder, pp. 75-80, fig. 35.

Engineering Geology

Some of the usefulness of geology as applied to engineering problems has been expressed in several reports, as follows:

Applications of geology to civil engineering, by Douglas Clark. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 1 and 2, January and April 1933, pp. 161-173.

Mechanics of the Lone Mountain landslides, San Francisco, California, by William M. Cogen. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 32, no. 4, October 1936, pp. 459-474, 14 figs.

Doing something about earthquakes, by R. R. Lukens. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 1, January 1928, pp. 21-26, 6 figs.

Technique in Geology

From time to time, some interesting or unique method of doing geology or expressing geologic features has been presented by the Geologic Branch:

Aerial photography and its importance to California geologists, by Leon T. Eliel. Cal. St. Div. Mines, Mining in Calif., vol. 26, no. 1, January 1930, pp. 64-71, 5 illus. (*Published under* "Special Articles".)

Preparation of a new relief map of California, by H. A. Sedelmeyer, Cal. St. Div. Mines, Mining in Calif., vol. 27, no. 1, January 1931, pp. 73-77, 3 illus.

Tracing buried-river channel deposits by geomagnetic methods, by Elmer W. Ellsworth. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 29, nos. 1 and 2, January and April 1933, pp. 244-250, 2 figs.

Use of geology in seeking gold, by Olaf P. Jenkins. Mining Jour., Ariz., vol. 17, no. 2, June 15, 1933, pp. 3-4.

New technique applicable to the study of placers, by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 31, no. 2, April 1935, pp. 143-210, 35 figs., 1 geological map (pl. III).

New State geologic map—method of mounting, by Olaf P. Jenkins. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 2, April 1938, pp. 127-129, 1 fig.

Use of ultra-violet light in prospecting for scheelite, by Ott F. Heizer. Cal. St. Div. Mines, Cal. Jour. Mines and Geology, vol. 34, no. 3, July 1938, pp. 331-333. (*Published under* "Special Articles".)

Progress Reports and Notes

In each issue of the California Journal of Mines and Geology (prior to 1933 it was called Mining in California) the Geologic Branch has been given space in which to present a progress report. These progress reports, now called ''Current Notes,'' started in the April, 1930, issue, and have continued throughout all subsequent numbers of the quarterly chapter of the State Mineralogist's Reports. Progress reports of the Geologic Branch have also been included in the State Mineralogist's biennial reports.

These and other notes have from time to time also appeared in the *California Conservationist*. Also, progress reports of the Geologic Branch have been presented before various technical meetings and published in the reviews of various journals.

A geological survey of California, by Olaf P. Jenkins. Science, vol. 70, no. 1823, December 6, 1929, p. 554.

A geological survey of California, by Walter W. Bradley and Olaf P. Jenkins. M Metal 11, 1930, pp. 520-521.

Geological survey of California under way, by Olaf P. Jenkins. Oil Bull. 16, no. 11, 1930, pp. 1158-1159, 1236, 1 map.

Development of geological survey of California State Division of Mines, by Olaf P. Jenkins. Amer. Assoc. of Petroleum Geologists, Bull. 14, October 1930, pp. 1352-1355.

Progress of the geological survey of California, by Olaf P. Jenkins. Science, vol. 72, no. 1873, November 21, 1930, pp. 528-529.

California geological survey, by Olaf P. Jenkins. Mining Jour., Ariz., vol. 21, 1931, p. 4.

Progress of the geologic map of California, by Olaf P. Jenkins. Amer. Assoc. of Petroleum Geologists, Bull. 19, 1935, p. 135.

CONCLUSIONS

With a staff of only three, a geologist, an office assistant, and a draftsman, the Geologic Branch has been responsible for the publication of more than 90 reports (many of major importance) during the last eleven years. The scope of these reports has been broad, covering both applied and basic geology. Had it not been for the support of a large number of geologists not members of the State organization, this record would have been far short of this figure. To all these persons who have cooperated in the geological program of the Division of Mines, the Geologic Branch wishes to express appreciation and gratitude.

CALIFORNIA EARTHQUAKES OF THE MISSION PERIOD, 1769-1838

By Robert F. Heizer*

The employment of historical accounts for ascertaining the time and place of past events, is, of course, their primary use. Such records are unique, in that they are often the only evidence we have of happenings in earlier times. In this short paper are presented certain data bearing upon California earthquakes which are attested in the various historical records such as explorer's journals, mission records, and the like.

There are a number of published lists of earthquakes in California (Townley and Allen 39, pp. 6-9), and for practical purposes these should be sufficient; yet they do not, in grand total, give complete data. What few new bibliographic citations this paper will offer, together with the relatively great interest of Californians in the subject, give justification for its writing.

The earliest record of earthquakes in California is found in the several journals of the Portolá expedition of 1769. The intensity of these apparently severe quakes and the persistence of successive aftertremors have been underestimated by most writers. Of the several journals of the expedition that mention this series of shocks, the diary of Miguel Costansó, the engineer, is most careful and complete.

Costansó (11, p. 7), on July 28, 1769, wrote:

> "At this place (Santa Ana River) we experienced a terrible earthquake, which was repeated four times during the day. The first vibration or shock occurred at one o'clock in the afternoon, and was most violent; the last took place about half-past four. One of the natives who, no doubt, held the office of priest among them, was at that time in the camp. Bewildered, no less than we, he began, with horrible cries and great manifestations of terror, to entreat the heavens turning in all directions, and acting as though he would exorcise the elements. To this place we gave the name of *Rio de los Temblores* (River of Earthquakes)."

Portolá (09, p. 21) gives a slightly different version. He says, "Here, at twelve o'clock, we experienced an earthquake of such violence . . . supplicating Mary Most Holy. It lasted about half as long as an Ave Maria, and, about ten minutes later, it was repeated though not so distinctly." For a third, shorter account of this day's quakes, see Fages (37, p. 14). The following day passed without note of tremors, but on July 30, 1769, Costansó (11, p. 19) stated, "In the afternoon we felt another earthquake." On the next day (July 31) Costansó (11, p. 19) says, "At half-past eight in the morning we experienced another violent earthquake." Portolá (09, p. 23) adds, "We experienced six or seven severe earthquakes." These Spanish explorers on their way northward had little respite from shocks, for on the next day (August 1, 1769) Costansó (11, p. 19) says, "At ten o'clock in the morning there was an earthquake, which was repeated with violence at one o'clock in the afternoon; and one hour afterwards we experienced another shock.'' August 2 came, and with it ''three successive earthquakes during the afternoon and night'' (Costansó, M. 11, p. 21). Portolá (09, p. 23) merely said, ''We felt four or five earthquakes.'' Finally, on August 3, this hardy little group had the last of their experiences with the shocks, and Costansó (11, p. 21) says, ''In the afternoon there were other earthquakes; the frequency of these amazed us.''

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The year 1770 seems to have produced only one dubious record, otherwise unnoticed and therefore possibly in error (Townley and Allen 39, p. 21).

Fray Pedro Font (Bolton, H. E. 31, p. 158), near the east end of the Cahuilla Valley in Riverside County, records an earthquake on December 26, 1775 in these words:

> "It must have been about five in the afternoon when we felt a tremor of very short duration that appeared to be an earthquake, accompanied by a short, sharp rumbling. After a short time it was repeated very indistinctly."

Quakes are mentioned by Townley and Allen (39, p. 21) at Fort Yuma in 1776, and in Inyo County in 1790.

At San Juan Bautista from October 11 to October 31, 1800, were felt a series of shocks, sometimes as many as six on one day. On October 18 the quakes were most severe. Several cracks appeared in the ground, one of considerable extent and depth along the Pajaro River. The natives reassured the Spanish friars, saying that such quakes were common here, and that from the subterranean fissures or caverns formed by them salt water sometimes issued forth (Bancroft, H. H. 86, pp. 558-559). The following month (on November 22, 1800), southern California received a general earthquake. The adobe walls of the barracks at San Diego and the walls of the church at San Juan Capistrano, then under construction, were cracked (Bancroft 86, pp. 654, 658). On May 25, 1803, an earthquake slightly damaged the church at San Diego (Bancroft 86a, p. 106). At Mission San Gabriel in 1803 (exact date not recorded) a severe quake cracked the roof arches so badly that they were made unsafe and later torn down and a new roof of timbers and tile were substituted (Bancroft 86a, p. 114). The only earthquake recorded in 1804 is said to have cracked the chapel walls at the Pueblo of San Jose (Bancroft 86a, p. 135). On March 24, 1806, at midnight, an earthquake cracked the chapel wall at the mission of Santa Barbara. In the months of June and July, 1808, a series of rather severe shocks was felt at San Francisco. On July 17, 1808, the Commandant, Arguello, wrote complainingly to Governor Arrilaga as follows (Bancroft 86a, p. 129):

> "I notify you that since the twenty-first day of June there have been felt at this presidio some earthquakes, eighteen shocks to date, and among them some so violent that as a result of them the walls of my house have been cracked, being badly built so that one of my rooms was ruined; and if the shocks have done, until now, no further damage, it is because they have found no chance for lack of dwellings. The quarters of Fort San Joaquin threaten ruin and I fear that if the shocks continue there may happen some unfortunate accident to the troops stationed there."

Arrilaga, accustomed to an earthquake country, is said to have advised the commandant to go home and repair his house for the winter, and ''not to mind such trifles as earthquakes,'' giving him a box of dates for consolation.

The year 1812 saw great destruction by a series of earthquakes, and was known henceforth in Spanish California as *el año de los temblores.* The shocks came on two days in December (Bancroft 86a, pp. 347-348; Townley and Allen 39, pp. 22-24). On the 8th, the church at San Juan Capistrano was destroyed. This was apparently a local shock, yet the movement was felt at Purisima. On the 21st there was felt a more general shake which was disastrous at Purisima and Santa Barbara, less so at Santa Inez. A Spanish ship which lay at anchor at San Buenaventura, 38 miles from Santa Barbara, was injured by the shock (Trask 73, p. 85). This is the first of two instances noted in this paper of anchored ships receiving earth shocks.

On December 8, 1812, the earthquake came during early mass, when about 150 people were attending service at San Juan Capistrano. The church, 90 by 180 feet, had thick walls, and an arched, dome-like roof, all made of irregular and unshaped stones imbedded in mortar or cement. The construction was more at fault than the strength of the shock, according to Bancroft. The front tower, at the second movement of the quake, fell upon the arched roof and in a moment the mass of rock and timber fell upon the entire congregation of Indian neophytes, crushing them beneath the wreckage. The padre, standing in the offertory, escaped by the sacristy door. Before the shock was felt, a loud, rushing noise was heard in the east, and also out on the ocean, though there was no breeze to carry the sound. Several people were warned by this noise and left the church, thus escaping destruction in its collapse. The bodies of about 40 neophytes were recovered from the ruins.

Several light shocks were felt on December 8, 1812, at Mission Purisima (Bancroft, 86a, p. 367). On December 21, 1812, the other destructive shock was felt. The church at Santa Barbara was demolished and a new one was erected a few years later. At Purisima on this day the first quake was felt at 10:30 a.m. with a severe shaking which lasted for 4 minutes, and cracked the church wall. Just before 11:00 a.m. came another furious shock of 5 or 7 minutes duration which brought down the church in ruins. In the evening of the same day were felt five or six light shocks, and more came the next morning. At Santa Inez on this memorable day were felt two shocks, coming about 15 minutes apart. These brought down a corner of the church, ruined all the mission roofs, and caused great cracks to appear in many walls.

At Santa Barbara the earth opened in several places and ''sulphur volcanos,'' appeared. Several asphaltum springs were formed in the mountains and the tulares, and ''gaps'' (fissures?) appeared in the sierra. The shore volcano was stated to have more openings. This puzzling ''volcano,'' described at length by Martinez (38, pp. 38-39) in 1792, was probably a burning asphalt spring. Its location was between the Santa Barbara Channel and Purisima. Padre Gil said there was a huge earthquake wave at sea. A stick with a pendant ball was set up at intervals for 15 days. This rude contrivance seems to be the first seismologic instrument used in California. At Purisima Mission the earth opened, emitting water and black sand.

Trask (73, pp. 85-86) describes the effect of this earthquake upon the sea at Santa Barbara, saying:

> "The sea was observed to recede from the shore during the continuance of the shocks, and left the latter dry for a considerable distance, when it returned in five or six heavy rollers, which overflowed the plain on which Santa Barbara is built. The inhabitants saw the recession of the sea, and being aware of the danger of its return, fled to the adjoining hills near the town to escape the probable deluge.
>
> "The sea on its return flowed inland little more than half a mile, and reached the lower part of the town, doing but trifling damage, destroying three small adobe buildings."

San Francisco also felt the 1812 earthquakes, and it is stated that "tidal waves" covered the ground which the old plaza occupied. Throughout March, 1813, earthquakes were felt in southern California. In 1815 a series of quakes were felt at Santa Barbara—on January 18, five shocks; January 30, more shocks; July 8, 9, six shocks. Bancroft's History gives bare mention of earthquakes in 1818 (Santa Clara), 1821 (San Buenaventura and San Luis Rey), and in 1824.

There is a mere mention of an earthquake at San Gabriel Mission in 1825. Duhaut-Cilly (29, p. 248; *also* Bancroft 86a, p. 568) says:

> "The church had been thrown down, two years before (i.e., 1825) by an earthquake, and they were busy building another."

In April or May, 1827, Duhaut-Cilly (29, p. 148) gave us our best account of the shocks at San Francisco. He said:

> "This bad weather had been preceded by a heavy earthquake. One night, toward four in the morning all of us were awakened by a remarkable noise, and particularly by a shaking which made us believe, at first, that the ship had just been cast upon the rocks. The vessel shivered and cracked in every part, and the chain anchoring us made a frightful noise. When we were satisfied that we had not moved it was not difficult to recognize the cause of this alarm. The duration of the sound and shock was about eight seconds.
>
> "The next day the people at the Presidio, still much frightened, told us they had passed a part of the night out of doors; that the shocks had been several times repeated and that all the houses were more or less shaken and damaged.
>
> "Fray Tomas also wrote me that the mission buildings had suffered in some respect, adding merrily: 'In the church the statue of San Emilio fell from his niche and broke his arm; but as for San Isidro el Labrador, he remained firm, leaning on his spade.' "

This is the second record of an anchored ship being shaken by an earthquake. (Still another instance, mentioned for its interest, was felt by Duflot du Mofras in 1841 while at sea off the California coast.) Although Duhaut-Cilly (29, p. 148) said in 1827, "It is Saint Aemilius who is invoked in California againt earthquakes," it was not until after the earthquake of 1868 that the feast day of Saint Emidius (August 9) was set apart as a day of prayers for protection against earthquakes by Pope Pius IX, at the request of the Archbishop of California, according to Townley and Allen (39, p. 52).

On September 23 (?), 1827, at Los Angeles about 8:00 P.M. a severe earthquake shock was felt. Later, another shock was felt (Duhaut-Cilly 29, pp. 248-249; *also* Bancroft 86a, p. 563).

Several severe shocks were felt at San Francisco in September, 1829, and in 1830 the church at San Luis Obispo received injuries due to a quake (Townley and Allen 39, p. 24). On April 25, 1836, Monterey felt an earthquake (Bancroft 86b, p. 670; 86c, p. 78). In the same year (1836) on June 9 and 10 severe shakes were felt from Monterey northward (Bancroft 86b, p. 670; 86c, p. 78). In June and July of 1838 a general series of quakes was felt at San Francisco, San Jose, Santa Clara, and Monterey (Bancroft 86b, p. 670; 86c, p. 78). These quakes were also felt east of San Francisco Bay where great fissures were made in the earth (Townley and Allen 39, p. 24).

The present list of earthquakes covers adequately the period 1769-1838. For the following near-century (1839-1928) the reader is referred to Townley and Allen's compilation (39, pp. 25 ff.).

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OCCURRENCE OF SCHEELITE IN IDAHO-MARYLAND MINES AT GRASS VALLEY, CALIFORNIA

By Rollin Farmin*

During World War I, scheelite valued at approximately $100,000 was produced at the Union Hill mine by Mr. Errol MacBoyle and associates. Ten tons of rich ore was cobbed from a "pocket" in the Greek-Tungsten vein and about 24 tons of 60%-WO_3 ore was milled from an adjacent zone of stringers in the slate country rock. The rich ore was sacked, put on a raft and floated out from half-submerged workings to the 600-ft. station of the Union Hill shaft. Free gold was visible in some of the ore, intergrown with the scheelite and with the surrounding gangue of vein quartz and ankerite. The scheelite-rich ore soon was exhausted and mining proceeded on gold-quartz ore in which only small masses ranging up to one pound occasionally were found.

In the adjoining Brunswick and Idaho units of Idaho Maryland Mines Corp., scheelite occurs sporadically as grains or small masses in the gold-quartz veins and in their associated stringers. No scheelite has been recognized in the altered wall rock adjoining the quartz "filling." The mineral is recognized easily in the white vein quartz by its amber color, luster and ragged cleavage masses and would not escape detection long except perhaps in the altered wall rocks.

The scheelite occurs in anhedral, compact masses that tend to be globular in the wider veins but necessarily are elongate in the narrow stringers. The masses are isolated and do not fill fractures in the quartz but rather are intercrystallized with quartz and ankerite, as an original component of the vein filling. Scheelite is so small a constituent of the Idaho-Maryland-Brunswick ores that mill concentrates currently show scarcely a trace of tungsten.

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* Geologist, Idaho Maryland Mines Corporation. Manuscript submitted for publication September 19, 1941.

TUNGSTEN RESOURCES OF CALIFORNIA*

By John F. Partridge, Jr.**

OUTLINE OF REPORT

Page
INTRODUCTION 228
  Acknowledgments 228
  Purpose and scope of report 228
  History of California tungsten 229
ECONOMICS OF TUNGSTEN 230
  Uses of tungsten 230
  Price of tungsten 232
  Survey of past prices 232
  Domestic tariff history 234
  Strategic importance of tungsten 235
MINERALOGY OF TUNGSTEN 237
  Minerals containing tungsten 237
    Wolframite 237
    Ferberite 237
    Hübnerite 238
    Scheelite 238
    Tungstite 239
    Tungstenite 239
    Thorotungstite 239
    Ferritungstite 239
    Powellite 239
    Chillagite 239
    Raspite 239
    Stolzite 239
    Cuprotungstite 240
    Cuproscheelite 240
    Reinite 240
  Tenor of the ore 240
GEOLOGY OF TUNGSTEN ORES 240
  Literature 240
  General geology 241
  Placer deposits 260
    Wolframite placers 260
    Scheelite placers 260
    Placer deposits as an aid to prospecting 261
  Vein deposits 261
    Pegmatitic and hypothermal vein deposits 261
      Mineralogy 262
      Burma deposits 262
    Mesothermal and epithermal deposits 263
      Mineralogy 263
      Structure 263
      Boulder County deposits 263
      Zaca Mine deposit 264
      Atolia deposits 264
      Golconda deposit 266
    Contact-metamorphic deposits 266
      Mineralogy 267
      Structure 267
      Order of mineralization 268
      Conditions of mineralization 269
      Tenor of deposits 269
  Conclusion 269

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OUTLINE OF REPORT—Continued

Page
ORE DRESSING 269
  Methods of treating tungsten ores 270
    Hand-sorting 270
    Gravity-concentration methods 270
    Grinding and crushing 270
    Classification 271
    Jigging 271
    Tabling 271
    Slime treatment 272
    Dewatering 272
    Magnetic separation 272
    Roasting 273
    Pneumatolytic concentration 273
    Centrifugal concentration 273
    Assaying of tungsten products 273
    Flotation of tungsten minerals 274
  Examples of practice 276
    Atolia placer plant 276
    Union Mine ore plant 276
    Atolia flotation plant 277
PRODUCTION OF TUNGSTEN IN CALIFORNIA 278
  Period from 1905 to 1914 279
  Period from 1914 to 1919 279
  Period from 1919 to 1929 280
  Period from 1929 to 1938 281
CALIFORNIA TUNGSTEN DEPOSITS 282
  Atolia District 283
    American Gold and Tungsten Corporation 284
    Atolia Mining Company 284
    Atolia-Rand Placers (formerly known as Nieto Placer Group) 285
    Black Hawk Tungsten Mine 285
    Buckeye Tungsten Mine 286
    Capitola Mine 286
    Federal Company's Group 286
    Gold Crown Consolidated 287
    Gustave Group 287
    Gypsy Group 287
    Jersey Lily Group 288
    W. H. Mann Property 288
    Monarch Tungsten Gold Mining Company 288
    Osdick Group 288
    Placer Gold Company 289
    Quirk Claims 289
    Rose Fraction 289
    Royal Bohee Group (Royal Bohn) 289
    Santa Ana Gold Mines 290
    Scheelite Group 290
    Sunshine Prospect 290
    Toboggan Group 290
    Treasury Group 291
    Winnie Mine 291
    Yellow Aster Mine 291
  Bishop District 292
    Adamson Tungsten Deposit 292
    Bishop Tungsten Company 292
    Boyd and Welch 293
    Chipmunk Deposit 293
    El Diablo Mining Company 294
    Mac Van Claim 295
    Pine Creek Tungsten Mine 295
    Round Valley Tungsten Mine (Stevens, Borchim, and Shiveley groups of claims) 296
    Scheelite Group 297
    Shannon Creek Tungsten Deposit 298

OUTLINE OF REPORT—Continued

Page

CALIFORNIA TUNGSTEN DEPOSITS—Continued
  Bishop District—Continued
    Tungstar Mine (Crawford Deposit) 298
    Tungsten City Milling Company 299
    Tungsten Mining Company 300
  Kernville District 300
    Cadillac Claim 300
    Corporal B.E.K., Texas Star No. 1 and No. 2 Claims 301
    Good Hope and Little Dick Group 301
    Herschel Kelso Claim 302
    Rand Group 302
    Tungsten King Mine 303
    Wall Street Group 304
  Weldon District 304
    Why Not Claim 305
  Eastern San Bernardino County District 305
    Argosy Mine 305
    Carbonate Group 306
    Confidence Copper Mine 306
    J. C. and W. O. Kinsman Claims 306
    Lombard and Main Group 307
    Mojave Annex Mine 307
    Mojave Tungsten Mine 307
    Sagamore Mine 308
    Shafer, Schloerb, and Field Group 308
    Tungsten King Group 308
  Miscellaneous deposits 309
  El Dorado County 309
    Comeback Consolidated Mine 309
  Fresno County 309
    Rhodes and Brown Deposit 309
    Wm. Terrill Prospect 309
  Inyo County 310
    Alvord Group 310
    Darwin Deposits 310
    Deep Springs Valley Deposit 310
    Emergency Group 311
    Feldman Tungsten Mine 311
    Monarch Tungsten Mine 311
    Waucoba Tungsten Deposit 312
  Kern County 312
    Blue Point Deposit 312
    Cecil and Clarence Pascoe Group 313
    Green Monster Mine 313
    J. Hodgson Claim 313
    Sunset Group 313
  Madera County 313
    Beasore Group 313
    I. X. L. Claim 314
    Silver Horde Mine 314
  Mono County 314
    Black Rock Tungsten Mine 314
  Nevada County 315
    Empire and North Star Mines 315
    Union Hill Mine 315
  San Bernardino County 316
    Four Brothers Mine 316
    Guadalupe Tungsten Mine 316
    Shadow Mountain Deposits 316
    United Tungsten Copper Mines 317
  San Diego County 317
    Gold Standard Group 317
    Oak Grove Tungsten Mine 318
  Shasta County 318

OUTLINE OF REPORT—Continued

Page
CALIFORNIA TUNGSTEN DEPOSITS—Continued
Tulare County ---------- 318
Anita May Claim ---------- 318
Jack Ranch Mine ---------- 318
Tungstore Mine ---------- 318
Verne Tyler Mine ---------- 319
Tuolumne County ---------- 319
CONCLUSION ---------- 319
BIBLIOGRAPHY ---------- 321
ILLUSTRATIONS ---------- 235

INTRODUCTION

Acknowledgments

The study of the tungsten resources of California was suggested to the author in September 1939, as a possible subject for a thesis, by C. A. Dobbel of the Department of Mining Engineering at Stanford University. The work was carried on entirely under his guidance and supervision. The useful hints and suggestions made by him are deeply appreciated by the author, who also feels indebted to him for the numerous plates photographed, developed, and printed in his own laboratory.

The California State Division of Mines made every effort to cooperate in this work, and special thanks are extended to Mr. Walter W. Bradley, State Mineralogist; Dr. Olaf P. Jenkins, Chief Geologist; Mr. W. B. Tucker, District Mining Engineer, Los Angeles; Mr. H. H. Symons, Statistician; and Mr. Alfred L. Ransome. Appreciation is also extended to Mr. Edwin P. Meadows and his W. P. A. staff for their part in compiling part of the data.

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Purpose and Scope of Report

The prospect of a general European war in 1938 aroused an interest in the so-called strategic minerals.[1] At this time Alfred L. Ransome and John L. Kellogg (39) prepared a report on the quicksilver resources of California. In 1939 it was suggested by Professor C. A. Dobbel that, as a continuation of the work on strategic minerals, this paper on the tungsten resources of California be written. The cooperation of the California State Division of Mines was obtained and work was started.

The purpose of this report is to present a clear, concise, and complete study of the present knowledge and status of the economics, geology, mining, and metallurgy of tungsten. Although the various State Mineralogists' Reports and State Bulletins contain brief descriptions of the tungsten industry in California, no complete study of this kind has been published to this date.[2] At present the United States Geological Survey is conducting a survey over the entire United States, under the Strategic Minerals Division. Results of their study will be more complete and detailed than this report can possibly be, but it is hoped that the present work will fill the gap for the next few years, before the Survey work can be completed and the results published.

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[1] *Strategic minerals* are those minerals carrying elements which are necessary, either directly or indirectly, for the waging of war and which are not produced in the United States in quantities sufficient for its needs. The four principal strategic elements of California are quicksilver, tungsten, manganese, and chrome. *See* Merrill, C. W. 38, p. 283.

All the various sources of knowledge have been examined, and private communications have been used, in order to gain as much information as possible on the subject. The compilation of all the data under one cover is in itself of value, when one considers the wide range over which the information is spread. The tungsten industry is at present operating on a low-production basis; but a sudden rise in prices, such as experienced in the last war and during the present European war by the quicksilver industry, will create widespread interest in tungsten resources and probably will make demands for tungsten beyond present production figures.

The chapter on the economics of tungsten is designed to give a brief picture of the uses, prices, and production of tungsten in the United States, since the inception of the industry at the turn of the century. The chapters on mineralogy and geology are closely related, and a general survey of these fields is given which may be of use in prospecting for new deposits. The study of the metallurgy and the ore dressing of tungsten-bearing minerals is limited to discussion of past and present practice, clarified by actual examples of old and new mills. No attempt is made to solve the milling problems which face the industry, as such a solution would be the subject for a treatise in itself. Instead, these problems are merely pointed out. The mining methods are, in general, simple and follow standard practice; consequently, no consideration has been given them herein. The main emphasis is placed upon the geological occurrences of tungsten minerals, the various California deposits, and the prospects of enlarging the industry in California.

History of California Tungsten

Although tungsten-bearing minerals have been known for a number of years to exist in California, tungsten mining is a relatively recent industry. The first production on a commercial scale was in 1905 from the Stringer district in eastern Kern County, a mile or two south of Randsburg. In 1906 the rich deposits of Atolia were discovered and California became an important tungsten producer. Production continued until, in 1914, the Atolia district surpassed the Boulder Creek district of Colorado to lead the entire United States. To the end of 1914, the value of the total output of California had amounted to $1,513,936. In 1915 alone the output reached $1,005,467. In 1915 and 1916, when the price rose considerably, prospecting was greatly stimulated and new deposits were discovered and developed.

The contact-metamorphic deposits of the Bishop district were discovered by J. G. Powning (Hess and Larsen 22, p. 245) through the finding of scheelite in gold placers. These deposits did not attract attention until 1916, when the Standard Tungsten Company and the

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[2] In 1917-1918, a survey of the tungsten resources of California was made by the State Mining Bureau (now Division of Mines), and the report written by Clarence A. Waring (since deceased). It was intended to publish it as a part of Bulletin No. 80, "Tungsten, Molybdenum, Vanadium, Nickel, in California", but lack of funds prevented its being printed. *Walter W. Bradley, April 10, 1941.*

Tungsten Mines Company acquired claims and completed mills within two months, and started production. The mill of the Pine Creek Tungsten Company was not completed until late in 1918.

The high price of tungsten, which was stimulated by the World War, brought on a tremendous increase of interest and activity. It was during this period that most of the tungsten deposits were discovered and opened. When prices fell after the war, activity ceased and, in 1921 and 1922, no production was made in the United States. With the passage of the tariff on foreign tungsten ores and concentrates in 1922, the tungsten industry was revived and production has been increasing up to the present date. The Atolia Mining Company, however, has been the only consistent producer. With the present European war, interest has been stimulated again, and California is entering a new era of tungsten production.

ECONOMICS OF TUNGSTEN

In 1898, F. W. Taylor (Vanderburg, W. O. 35, p. 2), in collaboration with Maunsel White, developed a tool steel that could be used at higher speeds and with heavier cuts than any heretofore available. The Bethlehem Steel Company manufactured this new type of steel, and exhibited it in Paris at the Exhibition in 1900. A low tungsten content was responsible for the properties of this steel. In 1903 Robert A. Hadfield (03) published the results of his studies on the properties of tungsten steels. With these two important contributions, a new era of steel-working was born, and also a new industry—tungsten mining.

Tungsten had been known since 1781. When K. W. Scheele demonstrated the presence of a new acid, which he named tungstic acid, in the mineral then known as tenn-spat, or heavy-spar (Levy, S. I. 15, p. 31). As early as 1855 (Gurlt, A. 93, p. 236) tungsten had been used in Europe as an alloy with steel. and patents had been issued in France. In 1857 a patent was issued in England for alloys of tungsten with iron, nickel, and other elements. The first useful alloy was patented in 1868 (Vanderburg, W. O. 35). This steel, which is now obsolete, contained 6 percent tungsten and 2 percent manganese.

With the advent of this new type of cutting tool, which did not lose its hardness at high temperatures and which could make heavier cuts than other cutting tools, dies, lathes, drill presses, and the like became obsolete. Other types had to be designed with greater strength, to meet the heavier service. Deposits were exploited, and tungsten became prominent among the elements mined in the United States.

Uses of Tungsten

Although the most important use of tungsten is as an alloy with steel, there are other uses of importance to which it is put. These other uses may be grouped into the following four divisions: (1) cemented tungsten carbide; (2) non-ferrous alloys; (3) metallic tungsten; and (4) chemical compounds.

As stated above, by far the most important use of tungsten is as an alloy with steel. Tungsten-steel alloys make high-speed tool-steel which retains its hardness when heated to redness, and which takes a heavier cut than ordinary carbon steel. The use of this high-speed steel results in an increase of output per man and per machine and, as a result, in the saving of millions of dollars annually. With high-speed tungsten steel, one man and one machine can now do what formerly required five men and five machines.

Tungsten-steel alloys are also used as linings in part of machines which operate frequently at red heat, such as valve-seats in aeroplane engines, drawing dies, and gun breeches. Tungsten steel has been used for rails, prolonging their life approximately 5 years by the addition of only 0.3 percent tungsten. An alloy of 35 percent tungsten and 65 percent steel makes a projectile of high penetrating power. The cost of steel, however, makes this use limited (Vanderburg, W. O. 35).

A few of the other uses of tungsten-steel alloys are in hacksaw blades, files, cold chisels, razor and knife blades, stamps, watch springs, strings for musical instruments, phonograph needles, sounding plates for pianos, car springs, electrical resistance wire, drills, rolls for Pilger mills, shear blades for cutting hot steel, armor for submarine cables, telephone conductors, and transformer cores.

Cemented tungsten carbide has been developed only during the past decade, but it now threatens to displace the position of tungsten-steel high-speed tools in cutting efficiency, because of its extreme hardness. It was first developed in Germany, and the patents are held by Fried. Krupp Aktiengesellschaft, Essen, Germany (Vanderburg, W. O. 35). This substance is the hardest artificial material known, exceeding even corundum and approaching the diamond in hardness. Tungsten carbide tools will cut chilled castings, manganese steel, porcelain, mycalex (fine mica in lead borate), quartz, and numerous other hard substances. In this country, licensees manufacture it under the trade names of Carbaloy, Firthite, Firthalloy, and Dimondite. It is a high-priced cutting material ($450 per pound), but is often used as tips on steel shanks. It is threatening to displace diamonds in rock drilling and rock saws. It is also used in blast nozzles, gages, boring and reaming tools, blanking and drawing dies.

The use of tungsten as an alloy with non-ferrous elements is limited, on account of the high cost of manufacturing such alloys. In general, tungsten gives greater hardness and greater resistance to oxidation and erosion. An alloy of cobalt, chromium, and tungsten is used as a competitor of high speed tool steels, and for cutlery; aluminum which is hardened with a low percentage of tungsten is used for automobile construction in France, and for type metal; an alloy of copper, aluminum, and tungsten is used for propeller blades. In Germany, breeches for naval guns are made of an alloy of tungsten and from 2 to 10 percent cobalt. Various alloys have been used for electric lamp filaments. A copper-tungsten electrode for welding has been developed. Other alloys have been put to such uses as surgical instruments, jewelry, electrical contact points, pen points, high-speed bearing metals, safe and vault walls, filament supports for radio tubes, and receptacles where resistance to acid liquids or vapors is desired.

Tungsten metal has a high melting point, high heat conductivity, high specific gravity, high tensile strength, low vapor pressure, and is ductile. It is therefore an ideal material for electric-lamp filaments, and finds a widespread use in galvanometer suspensions, cross-hairs in telescopes, radio tubes, rectifying valves, X-ray tubes, surgical wire, and other similar objects.

Tungsten was recently deposited from an alkaline solution by electrolysis (Fink and Jones 31a). The deposit is smooth, hard, coherent, and has a high luster. It needs no further polishing if the object that was plated was previously polished. Because of its acid-resisting qualities, it is useful as a coating for numerous materials.

Chemical compounds of tungsten are used for dyes and paints. Sodium tungstate is used, among other things, as a mordant in dyeing, for rendering cloth non-inflammable, for weighting fabrics, in painting, for decolorizing acetic acid and acetates prepared from pyroligneous acid, and as a decorticator in preparaing raw fabrics for manufacturing. Fluorescent compounds of tungsten are used for intensifying in X-ray photography. Lead, zinc, and barium tungstates are used as substitutes for white lead; and various other salts are given such use as producing color in pigments, porcelain, and stained papers (Vanderburg, W. O. 35).

Price of Tungsten

The price of tungsten varies and reacts quickly to a change in demand. Since 1922, the price has been at an artificial level because of a severe tariff policy which was adopted by the United States.

The data used in the price-chart for tungsten were taken from a graph presented by G. A. Roush (39) in his recent book ''Strategic Mineral Supplies.'' Later prices were obtained from Bulletin 117 of the State Division of Mines (Symons, H. H. 39), and from the Engineering and Mining Journal. The price quoted for 1940 was as of April 23. In this graph the maximum, minimum, and average annual quotations are plotted. The variation in price for the year, the excessive peaks, and the average annual price received are thus shown.[3] With such a plot it is a simple matter to interpret the market conditions.

The price of tungsten is quoted in monetary terms per unit. In the United States the short ton unit of 20 pounds of WO_3 content per ton is used; in the British Empire the long ton unit of 22.4 pounds; and in France and Germany the metric ton of 22.04 pounds. There is no standard by which prices are set. They are based upon quotations on concentrates, generally containing 60 percent WO_3. Supply-and-demand bidding generally establishes the price in the United States; and since the supply in this country is below the amount consumed, demand affects the price sharply. A severe tariff attempts to protect the domestic producers from foreign imports, and maintains the price at an artificial level. Domestic scheelite generally draws a lower price than the Chinese wolframite, despite a higher WO_3 content and a greater ease of treatment. This lower price may be accounted for by the greater purity of the Chinese wolframite, which contains less molybdenum than the domestic product.

Survey of Past Prices

Prior to 1914 the price had shown variations in the maximum, from \$3 to \$14; in the minimum from \$1 to \$6.50; and for the average, from \$2.30 to \$9.00. These prices were under conditions of moderate demand, and were partially protected by a 10 percent ad valorem duty on tungsten ores from 1909 to 1913. From 1913 to 1914, after the Underwood Tariff Act had removed the import duty, prices took a small decline and production fell off 25 percent (Roush, G. A. 39, p. 155). This falling off in price was caught up rapidly from 1914 to 1915, when a heavy demand was made after the outbreak of the World War.

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[3] Quotations per short ton unit as of April 15, 1941 are: Chinese wolframite, duty paid, \$24.00; Domestic scheelite, \$23.00 @ \$24.00. *Note supplied by* Walter W. Bradley.

With the World War the price structure was radically changed. Heavy demands and hysterical buying inflated prices to ridiculous heights, and wide fluctuations in price were prevalent. In 1915 the prices rose from a minimum of $6.00 to a maximum of $52.00 per unit. In March of 1916, the all-time peak price of $93.50 per unit was reached. This dropped by the end of the year, however, to a minimum of $15.00 per unit. In 1917 a maximum of $25.00 was reached, and the minimum fell to $12.00. One surge in 1918 carried the price up to a maximum of $35.00. With the end of the war, the demand fell off and prices slumped accordingly. By 1919 the average price had fallen from $33.00 in 1916 and $24.00 in 1918, to $6.00.

Without the protection of a tariff and with little demand prices slumped to a low of $1.50 per unit in 1921, and domestic production consequently ceased. In 1922 a duty was again put on imports of tungsten ores and concentrates. The duty of 45 cents per pound of tungsten content was equivalent to $7.14 per unit. With this artificial boost, prices rose again and domestic production was renewed. Prices gradually increased from that time, with minor fluctuations, from an average of $8.50 per unit in 1923 to an average of $14.00 in 1929, the year of the depression. Although the demand was stable during this period, it was not excessive and the prices remained relatively low.

The demand fell off sharply in 1930, and in 1931 the prices likewise slumped. In 1932 prices reached a low of $9 per unit as an average figure. In 1934 prices rose along with an increase in demand to $15.00 per unit, average, and $18.00 per unit, maximum. Prices then remained relatively stable for the next two years. In 1937, when a heavy rearmament demand in the United States was made, prices took a sudden jump—in anticipation of a still heavier demand—to $35.00 per unit. The demand increased, but not as far as was expected, and the average price received was only $19.00. Although consumption fell off again in 1938, prices rose slightly to an average level of $21.00. During the first few months of 1939, prices continued to fall off to a minimum of $16.00. With the outbreak of the European War in September of that year, however, the price rose and finished the year at a maximum of $25.00. With the beginning of 1940, prices fell back to $20.00, but by April they had risen again to $23.50. It is expected that the rise will continue, with the renewed activity in Europe and with the recent adoption of a rearmament program in the United States.

The Chinese-Japanese war did not affect prices and domestic production, as was anticipated, mainly because the tungsten areas of South China were not reached by the Japanese army and exports were able to be made. Increased activity in the Far East might, however, close this channel, in which case domestic prices and production would likely again soar.

The accompanying price chart for tungsten shows clearly that demand, stimulated by war and rearmament activity, is the main factor in the price of tungsten concentrates, and not the general economic stability and eras of prosperity and depression. Although the prosperity of the country is reflected in a measure, in the demand, it is overshadowed by that production which is stimulated by rearmament and the probability and existence of war. The protective tariff likewise affects the price noticeably. This effect is not felt in periods of excessive requirements; but in normal times, it is the chief factor in maintaining a high price, and in sustaining a price at which domestic producers can operate successfully.

Domestic Tariff History

Since tariff plays such an important part in preserving the price of tungsten in normal times, the history of the tariff on tungsten ores and concentrates is included here.

Crude and metallic tungsten were both admitted free prior to 1909, by virtue of the Tariff Act of 1897. In 1909 a new tariff act was passed, which contained the following two clauses in reference to tungsten metal ores:

> "Tungsten or Wolfram metal, valued at $200 per ton or less, 25 per centum ad valorem; valued at more than $200 per ton, 20 per centum ad valorem. (par. 184).
>
> "Tungsten-bearing ores of all kinds, 10 per centum ad valorem. (par. 190)"

In 1913 the duty on tungsten metal was reduced to "15 per centum ad valorem. (Par. 102)," and "tungsten-bearing ores of all kinds were admitted free (Par. 633)".

Following the World War, when tungsten prices had hit a new low and Chinese wolframite was selling for $1.50 and $1.60 per unit in New York, and domestic production had ceased entirely, a need for a tariff was keenly felt. In the Fordney-McCumber Tariff Act of 1922, the following provision was consequently made:

> "Tungsten ores or concentrates, 45 cents per pound on the metallic tungsten contained therein; ferro-tungsten, metallic tungsten, tungsten powder, tungstic acid, and all other compounds of tungsten, 60 cents per pound on the tungsten contained therein and 25 per centum ad valorem; ferrochromium tungsten, chromium tungsten, chromium cobalt tungsten, tungsten nickel, and all other alloys of tungsten not specially provided for, 60 cents per pound on the tungsten contained therein and 25 per centum ad valorem. (Par. 302)".

The duty adopted was an equivalent of $7.14 per unit or to an ad valorem duty of 470 percent. This brought the price of duty-paid foreign ore up to $8.64 per unit (Roush, G. A. 39, p. 156), stimulated domestic production, and increased the domestic price as well as the foreign price. This caused the equivalent ad valorem duty to drop to from 140 to 240 percent from 1926 to 1928, and to from 80 to 160 percent in 1929. With the fall in prices during the depression this equivalent duty rose until, with the passage of the Smoot-Hawley Tariff Act of 1930 which increased the rate to "50 cents per pound on the metallic tungsten contained therein (Par. 302c)," the equivalent rate was increased to 505 percent. This figure is based upon an equivalent figure of $7.93 per unit duty and a price of $9.50 for Chinese wolframite.

The above rates seem excessive, but if viewed in the light of stimulating domestic production they appear to be warranted. Although the total production in the United States is now higher than it was before the World War, when only a 10 percent ad valorem duty was in effect, the average output is less. This is due primarily to the fact that operations costs have risen, and that the richer deposits were exploited and mined out during the 1914-1918 boom. Should the demand rise as is anticipated on account of the present war, these rates will lower correspondingly and hence become less excessive.

Strategic Importance of Tungsten

Tungsten, with its high efficiency in steel machining and its comparative scarcity in the United States, is one of the most important strategic minerals. Evidence of this lies in the meteoric rise in prices and production during the World War, and in the sudden increase in interest and activity which followed the rearmament demand in 1937 and the outbreak of the European War in 1939.

Although tungsten is included in the ferro-alloy group with manganese and chrome, its production curve does not follow the steel curve as closely as manganese and chrome. The tungsten demand depends upon the utilization of steel, and not upon the amount manufactured. Ferrotungsten is used for high-speed, heavy-duty, cutting tools, and the large-scale production of lathe-turned, drilled, and planed steel required in times of war increases the need for tungsten. This requirement is stimulated by the necessity for speed in times of emergency, and tungsten-steel tools have a comparative efficiency of from 3 to 5 times that of carbon steel. Although there are possibilities of obtaining substitutes, as yet none have been sufficiently developed to be of value, or to be counted upon to alleviate the position of tungsten.

Before the World War, Germany alone realized the importance of ferrotungsten in times of war, and she took measures to insure an adequate supply. At that time, Germany practically monopolized the world supply of ferrotungsten. In 1913, although she produced only one percent of the world supply, she controlled 60 percent of it. (Bliss, E. F. 19, p. 166). Great Britain and her possessions, on the other hand, produced 37 percent of the world output, but depended upon Germany for both ferrotungsten and tungsten-steel tools. In the United States only a few men realized the strategic importance which tungsten plays in the manufacture of munitions, and the greater part of the tool steel consumed was imported (Vanderburg, W. O. 35).

When the war broke out and the German supply was cut off, Great Britain immediately placed an embargo on all production within the Empire, and apportioned the output among the manufacturers of ferrotungsten. This embargo was immediately felt in the United States, and started a feverish activity with a resultant soaring of prices and rapid increase in domestic production. In 1917 the United States produced 70 percent of its consumption, compared with only 42 percent in 1913 (Roush, G. A. 39).

After such an experience, the strategic importance of tungsten was realized, and a study was made to determine the best way to insure a domestic supply in times of national emergency. Four suggestions have been proposed, to the end that an adequate supply be perpetually available (Vanderburg, W. O. 35).

1. Find substitutes for tungsten.
2. Cease domestic production and reserve the deposits solely for emergency use.
3. Accumulate and maintain a reserve of tungsten concentrates and metal.
4. Stimulate domestic production and exploration by tariff protection.

Recent experimentation has shown that tungsten can be replaced wholly or in part by molybdenum. Ritchie (30) states that all difficulties in the manufacture of molybdenum high-speed tools can be overcome. The fact still remains, however, that molybdenum is not as satisfactory as tungsten, else it would compete with tungsten under normal conditions. In order to be of maximum advantage, competition of this kind would be desirable, as conversion—in time of emergency—of tungsten to molybdenum steels could then be rapid and inexpensive. Other possibilities, in limited fields, are uranium, zirconium, and vanadium (Roush, G. A. 39). Tungsten carbide can readily be considered a partial substitute, as it requires less tungsten then do ferrotungsten alloys. The stellite alloys could likewise be considered as substitutes; although they contain tungsten, it is in smaller amounts.

If domestic reserves were left untouched, great difficulties would arise in times of emergency. The deposits would be undeveloped, and mills would have to be built. Mining and milling methods might be unsatisfactory, and a long lag period for experimentation and perfection of methods would doubtless be necessary before production could start. Exploration would be minimized and Government control necessary. Since delay in times of emergency is to be avoided, this program defeats itself except at an impractical cost. Development and improvements in technique would not be made, and progress in the mining industry would probably be affected markedly, especially if such a program should spread to other metals and minerals.

Stock-piles and reserves have thus far been contrary to American policy (Vanderburg, W. O. 35). The size of the stock-pile is difficult to determine; it depends upon the need for raw materials and the length of time that foreign imports are cut off. This sort of program is expensive to the taxpayer, and tends to do one of two things, depending upon the price offered by the Government. In case of a high price, domestic and foreign production are stimulated as in the case of gold, a large reserve accumulates rapidly, and our own natural resources are depleted. In the event of a low price, the domestic industry is stunted, and the result is the same as if the deposits had been reserved solely for emergency use.

At present the tendency seems to be to stimulate the domestic production and exploration by a tariff. Whether or not this policy is to be recommended is a debatable question. The present duty on tungsten ores (50 cents per pound of tungsten content) has forced an ad valorem duty of as high as 500 percent. Such a policy inflicts a punishment on the consumer, who must pay a higher price. On the other hand, a revenue is obtained and domestic mining is aided and stimulated.

Thus, realizing the importance of tungsten in times of national emergency, and its key position in the munitions industry, it is evident that the problem of keeping an adequate supply on hand is an acute one for which there is as yet no obvious solution. There is, however, one road open. It is not definitely known just how limited our resources are. When prices rose during the World War, prospectors uncovered innumerable prospects, many of which were never developed or prospected further on account of the sudden drop in prices. Since that time, other deposits have been discovered, most of which are low-grade prospects about which little is known. Until it is learned just how limited our resources are, a satisfactory conservation plan can not be inaugurated. The United States Geological Survey is at present conducting a survey of the United States under the Strategic Minerals Division, during which survey the actual resources of the United States will be determined. When that work is completed, it may be that a satisfactory plan of conservation, based upon one of the above proposals or a combination of them, can be developed.

MINERALOGY OF TUNGSTEN

There are fourteen known tungsten-bearing minerals, but of these only four are sufficiently abundant to be of commercial importance. The remainder may be considered rare minerals, and are frequently difficult to detect. Scheelite and wolframite are the two most abundant tungsten minerals, and they comprise the great bulk of ore mined in the world. Ferberite is locally important (Colorado); hübnerite is seldom found in commercial orebodies. Tungstite is the most common of the rare tungsten minerals, and is the usual alteration product of scheelite and wolframite.

The four commercial ore minerals are generally found in quartz veins. Scheelite is also found in lime-silicate rocks associated with garnet, epidote, quartz, and calcite. Wolframite is often found with cassiterite in tin-stone veins and in pegmatite dikes. Ferberite is usually associated with pyrite, sphalerite, galena, molybdenite, and fluorite (George, R. D. 09). Hübernite is ordinarily found with the common metallic sulphides, and also with other manganese minerals (Rogers, A. F. 37).

Minerals Containing Tungsten

Wolframite. An isomorphous mixture of iron and manganese tungstates, $(Fe.Mn)WO_4$ (tungsten = 60.6-60.7 percent); specific gravity 7.4±; hardness 5-5½; color, black or dark brown; luster, submetallic, opaque. Wolframite occurs in monoclinic crystals which are tabular parallel to a(100). Prismatic crystals are also abundant with vertical striations on the faces of the prismatic zone. It is found in bladed, lamellar, coarse divergent, columnar, and granular aggregations. Twins are found with c(001) as twin axis, and a(100) as composition face. Another common twin plane is k(023) (Dana, J. D. 15). There is a perfect cleavage parallel to b(010) and a parting parallel to a(100) and t(102). The fracture is uneven and the mineral is generally brittle. Wolframite is sometimes weakly magnetic. Under the blowpipe it is fusible at (3) to a magnetic globule. The sodium carbonate fusion is bluish green, due to the manganese content (Rogers, A. F. 37). It is soluble in aqua regia with the separation of a yellow residue of tungstic acid. Wolframite is a vein mineral associated with cassiterite, scheelite, and other high-temperature vein minerals. It is also common in pegmatite dikes. Wolframite is easily distinguished by its cleavage in one direction, high specific gravity, and sub-metallic luster.

Ferberite. Ferrous tungstate ($FeWO_4$), (tungsten = 60.6 percent); specific gravity 7.0-7.5; hardness 5; color, black; luster, metallic, opaque. Ferberite is one end of the isomorphous series of ferberite, wolframite, hübnerite. It has been suggested that ferberite should include that portion of the series containing up to 20 percent $MnWO_4$, hübnerite that portion containing up to 20 percent $FeWO_4$, and wolframite the portion in between (Dana, J. D. 15). Ferberite crystallizes in the monoclinic system and has a varied habit. It is tabular parallel to a(100) or b(010), almost equidimensional, or elongate parallel to b(010). It is found as crystals and also in masses. It is fusible at (2) to a magnetic globule. Ferberite occurs in quartz veins associated with the common metallic sulphides and fluorite. The high specific gravity, bright metallic luster, and one-directional cleavage make this mineral easy to identify.

Hübnerite. Manganese tungstate ($MnWO_4$), (tungsten = 60.7 percent); specific gravity 7.0±; hardness 5; color, reddish brown; streak yellow to yellow brown; luster, metallic-adamantine, translucent. Hübnerite forms the other end of the isomorphous series and grades into wolframite. It crystallizes in the monoclinic system; but euhedral crystals, which resemble wolframite, are rare. It usually occurs in bladed crystalline aggregates. There is a perfect cleavage parallel to b(010). Under the microscope it is biaxial, pleochroic, with extreme birefringence and a large angle 2V (73°). Fragments are elongate plates with strong birefringence. Under the blowpipe it is fusible at (4). The borax bead is amethyst colored in the oxidizing flame. Hübnerite is insoluble in acids, but the Na_2CO_3 fusion gives a yellow residue with HCl. Fragments are decomposed by HCl with a yellow residue of tungstic acid. Hübnerite generally occurs in epithermal quartz veins with the common metallic sulphides (Gianella, V. P. 38, p. 339), but is also found in high-temperature quartz veins, occasionally with other manganese minerals (Rogers, A. F. 37). It is easily identified by its high specific gravity and cleavage in one direction. It is distinguished from wolframite by its color and is more transparent.

Scheelite. Calcium tungstate ($CaWO_4$); (tungsten = 63.9 percent); specific gravity 6.0±; hardness 4½-5; white, gray, or pale colors; luster, sub-adamantine. Scheelite is tetragonal and occurs both as crystals and in massive form. Crystals belong to the tetragonal dipyramidal class. The habit is pyramidal with p(111) and e(101) as the dominant forms. There is a distinct cleavage parallel to e(101) (in four directions). Under the microscope it is uniaxial positive. Fragments are irregular with bright interference colors. Under the blowpipe it is fusible at (5). The $NaPO_3$ bead is blue in the reducing flame. It is decomposed by HCl with the separation of a yellow residue of tungstic acid, which is soluble in ammonia. Scheelite is commonly found in quartz veins of all three temperature groups, and is frequently associated with calcite. It is found as a minor constituent of contact-metamorphic rocks associated with garnet, epidote, calcite, quartz, molybdenite, and the common metallic sulphides. Scheelite follows wolframite in importance as an ore of tungsten, but is more abundant than the former in California. At present it is the only tungsten-bearing mineral mined in California. Scheelite is recognized by its cleavage, high specific gravity, and sub-adamantine luster. It is difficult to distinguish from quartz and calcite because of similar color and because of its presence in such small amounts. Under ultra-violet light scheelite is fluorescent and gives a characteristic light-blue color, even in daylight. In the dark the fluorescence is striking, and ultra-violet lamps are now widely used for prospecting and control in mining operations.

Tungstite. Hydrous tungsten trioxide (WO_3H_2O), (tungsten=73.6 percent); color, yellow or yellowish brown; pulverulent (Dana, J. D. 15), earthy. Under the microscope it is seen to occur in small scales which probably are orthorhombic. There is a perfect cleavage parallel to c(001). Tungstite is optically negative, and the angle 2V is small. It is secondary in origin and is commonly associated with wolframite, ferberite, hübnerite, and scheelite as a coating.

Tungstenite. Tungsten sulphide (WS_2), (tungsten=74.6 percent); specific gravity 7.4; hardness 2.5; color and streak, dark lead gray. It occurs in earthy masses or in foliated forms, and is found at the Emma Mine, Salt Lake County, Utah (Dana, J.D. 15).

Thorotungstite. Essentially tungstic and thorium oxide with small amounts of water, rare earths, zirconia, alumina, etc.; formula is doubtful; specific gravity 5-5.5. Crystals are tabular prismatic and probably orthorhombic. Crystals are microscopic and show parallel extinction under crossed nicols. Occurrence is as massive blocks or in microscopic crystals. It is found at the base of an alluvial deposit overlying granite at Pulai, in the Kinta District of Perak, Malay States (Dana, E. S. 32).

Ferritungstite. Hydrous iron-tungsten oxide ($Fe_2O_3WO_3.6H_2O$), (tungsten=41.5 percent); color, pale yellow to brownish-yellow when pure. It crystallizes in hexagonal plates which are evenly developed but minute in size. It gives off water in the closed tube and is decomposed by acids, leaving a yellow residue of tungstic acid. Ferritungstite is a secondary mineral, developing from the oxidation of wolframite. It resembles tungstite (Dana, J. D. 15).

Powellite. Calcium molybdate with calcium tungstate, $Ca(Mo,W)O_4$, (WO_3=10 percent); specific gravity 4.44; hardness 3.5. It crystallizes in minute yellow tetragonal pyramids. There is a cleavage parallel to (111). Under the microscope it is optically positive. It is fusible. Powellite is formed through the oxidation of molybdenite. It is frequently associated with scheelite (Dana, J. D. 15).

Chillagite. Lead tungstate-lead molybdate ($3PbWO_4.PbMoO_4$), (tungsten=17.2 percent); specific gravity 7.5; hardness 3.5. It crystallizes in tabular tetragonal crystals. It is yellow to brownish in color, and is easily fusible. Chillagite occurs at Chillagoe, New South Wales (Dana, E. S. 22).

Raspite. Lead tungstate ($PbWO_4$), (tungsten=40.4 percent): hardness 2.5; color, brownish yellow. It crystallizes in the monoclinic system in small crystals, tabular parallel to a(100). There is a cleavage parallel to a(100). It is fusible. It is optically positive, and 2V is almost 0°. Raspite occurs in the Broken Hill mines, New South Wales, and in the gold sands of Suni Duoro, Minas Geraes, Brazil (Dana, J. D. 15).

Stolzite. Lead tungstate ($PbWO_4$), (tungsten=40.4 percent); specific gravity 7.87-8.13; hardness 3; color, green to gray or brown.

Stolzite differs from powellite in that it crystallizes in the tetragonal system. The habit is pyramidal. It is easily fusible and is optically negative (Dana J. D. 15).

Cuprotungstite. Hydrous copper tungstate, $WO_3.2CuO.H_2O$; hardness 4.5; color, green. Occurs either in cryptocrystalline or fibrous forms. It is thought to be a replacement of the calcium in scheelite by copper (Schaller, W. T. 32).

Cuproscheelite. Calcium copper tungstate $(Ca,Cu)WO_4$; color, green. This mineral is apparently a stage of the alteration of scheelite to cuprotungstite by the replacement of the calcium by copper (Dana, J. D. 15).

Reinite. Ferrous tungstate, $FeWO_4$. It occurs in tetragonal crystals and is believed to be ferberite pseudomorphous after scheelite. It is an ore of tungsten, and is found in Kimbosan, Kei, Japan (Dana, J. D. 15).

Tenor of the Ore

Tungsten ores are variable in grade. The deposits first mined assayed as high as 14 or 15 percent tungstic acid. In some shoots at Atolia, large masses of nearly pure scheelite were mined, while the average grade was from 2 to 4 percent. In the large deposits now being worked, the average value is from 0.5 to 2 percent WO_3, the average being close to 1 percent. If the recovery of milling could be raised from 80 percent to a higher figure by increased slime recovery, ores of even lower tenor could be mined. The ore-shoots are generally limited in size to rather small bodies. Large disseminated deposits are not known to occur. The scheelite in the tactite deposits is present in shoots, and is not distributed through the rock as is often supposed.

GEOLOGY OF TUNGSTEN ORES

Literature

The purpose of this chapter is to compile and summarize all the available data on the geological occurrences of tungsten. The various districts of the world where tungsten has been mined at one time or another have been described in the literature; but the writer has found no satisfactory treatise on the geological occurrences of tungsten.

The first article on tungsten appeared in 1902 when Hobbs, in the 22d Annual Report of the United States Geological Survey, described an occurrence of tungsten minerals at Trumbull, Connecticut. In 1906, L. O. Kellogg (06, p. 654) described the occurrence of wolframite in veins in Arizona. Articles then appeared sporadically in the various publications until 1916. These articles are, in general, brief, and describe minor occurrences of tungsten minerals. Beginning in 1916 and throughout the World War period, there appeared a large number of articles on tungsten mines and deposits. The United States Geological Survey, State Mining Bureaus, and various foreign agencies sent men into the field to investigate the resources of this strategic metal which had suddenly become of such importance. Bulletin 652 of the United States Geological Survey, entitled ''Tungsten Minerals and Deposits,'' written by F. L. Hess and published in 1917, was of a general nature and was intended as an aid to prospectors with a minimum of technical training. Bulletin 640 of the Survey, "Tungsten Deposits of Northwestern Inyo County, California," by Adolph Knopf, was also published in 1917. This report described the contact-metamorphic deposits near Bishop, California, which were being exploited as a result of the tungsten boom, and which had risen in prominence in the world production of tungsten. Bulletin 725 of the Survey, "Contact-metamorphic Tungsten Deposits of the United States," by F. L. Hess and E. S. Larsen, was published in 1921. It described a typical occurrence of tungsten in the Western States. Other articles have appeared from time to time since then, describing new deposits and mines. The most notable of these later articles is the Nevada University Bulletin, Volume 28, 1934, "Geology of the Tungsten Deposits near Mill City, Nevada," which describes the deposits worked by the Nevada-Massachusetts Mining Company, at present the largest tungsten producer in the United States.

The four main tungsten-bearing minerals—wolframite, ferberite, hübnerite, and scheelite—are found in or near acidic, granitic, intrusive rocks, and they show a definite association with these rocks. Tungsten minerals are usually limited to the more acid types of granitic rocks, and represent the high-temperature, high-pressure stage of the consolidation of magma. Tungsten minerals are also known beyond this range, and are frequently found to have crystallized in the low-temperature, low-pressure range. It has been said that tungsten deposits are of a pneumatolytic origin (Rastall 18, p. 193)—that is, they are the product of the crystallization in fissures of the gaseous phase of igneous intrusion. In some cases this is undoubtedly true, but it does not hold for all occurrences. It actually represents a small and unimportant type of deposit.

General Geology

In order better to understand the nature of the geologic occurrences of tungsten minerals, we review briefly the nature of ore deposits in general. The classification proposed by Lindgren (33, pp. 211-212) will be adequate for the purpose:

I. Deposits produced by mechanical processes of concentration (placers)

II. Deposits produced by chemical processes of concentration
  A. In bodies of surface waters
    1. By interaction of solutions
      a. Inorganic reactions
      b. Organic reactions
    2. By evaporation of solvents

  B. In bodies of rocks
    1. By concentration of substances contained in the geologic body itself
      a. Concentration by rock decay and residual weathering near the surface
      b. Concentration by ground water of deeper circulation
      c. Concentration by dynamic and regional metamorphism

    2. By concentration effected by introduction of solutions foreign to the rock
      a. Origin independent of igneous activity by circulating atmospheric waters at moderate or slight depths

b. Origin dependent upon the eruption of igneous rocks
  (a) By hot ascending waters of uncertain origin, but charged with igneous emanations
    (1) Epithermal deposits
    (2) Mesothermal deposits
    (3) Hypothermal deposits
  (b) By direct igneous emanations
    (1) Pyrometasomatic deposits (intrusive bodies)
    (2) Sublimates and fumaroles (extrusive bodies)

c. In magmas by processes of differentiation
  (a) Magmatic deposits proper
  (b) Pegmatites

Tungsten deposits fall under several of the above classes. The most important producers of the world are the Chinese wolframite placer deposits, which are deposits produced by mechanical concentration processes. Tungsten minerals are refractory and are not broken down by weathering. This property, with their high specific gravity, enables them readily to form placer deposits which accumulate on top of the bedrock in cracks, crevices, natural riffles, and in layers. Very little is known of these placers, and no papers were found in the literature regarding them.

Other deposits, as well as the original source of the Chinese placers, are to be found in bodies of rock formed by the concentration of minerals brought about by the introduction of substances foreign to the rock, or in magmas formed by processes of differentiation. These deposits are, according to the terms of the above classifications, the epithermal, mesothermal, and hypothermal vein deposits, the pyromatasomatic deposits, and the pegmatite deposits.

In some respects the above classification is not entirely satisfactory. There is no real distinction to be had between hypothermal vein deposits and pegmatites. Both result from igneous intrusions, and both are in a sense the result of magmatic differentiation. In Cornwall there has been noticed a distinct gradation from pegmatites through hypothermal veins to mesothermal veins. Bearing this in mind, we shall hereafter not make the distinction which Lindgren makes between pegmatites and the hypothermal deposits, in considering the genesis of tungsten ores. We shall rather consider them both high-temperature vein deposits, one of which (the pegmatites) was more highly charged with volatile mineralizers such as fluorine, boron, and chlorine, when being formed.

When an igneous magma of an acidic granitic composition is intruded into a cover of older rocks and the magma begins to cool, there is a certain amount of differentiation which takes place. The more highly volatile substances are squeezed out, both in an aqueous and gaseous state, and rise through cracks and fissures which may be produced by the strains caused by the intrusion of the magma itself. Some authors have stated that fissures are opened by the forces produced by the crystallization of minerals, but this type of origin is doubtful. Although some of the matter is in a gaseous state, the majority is undoubtedly in an aqueous state, hence the use of the term ''hypothermal solution'' rather than ''pneumatolytic process,'' which indicates a gaseous state of all the matter. That these gases and solutions come from the center of the magma itself is evidenced by the

ILLUSTRATIONS FOR REPORT

By John F. Partridge, Jr.

TUNGSTEN RESOURCES OF CALIFORNIA

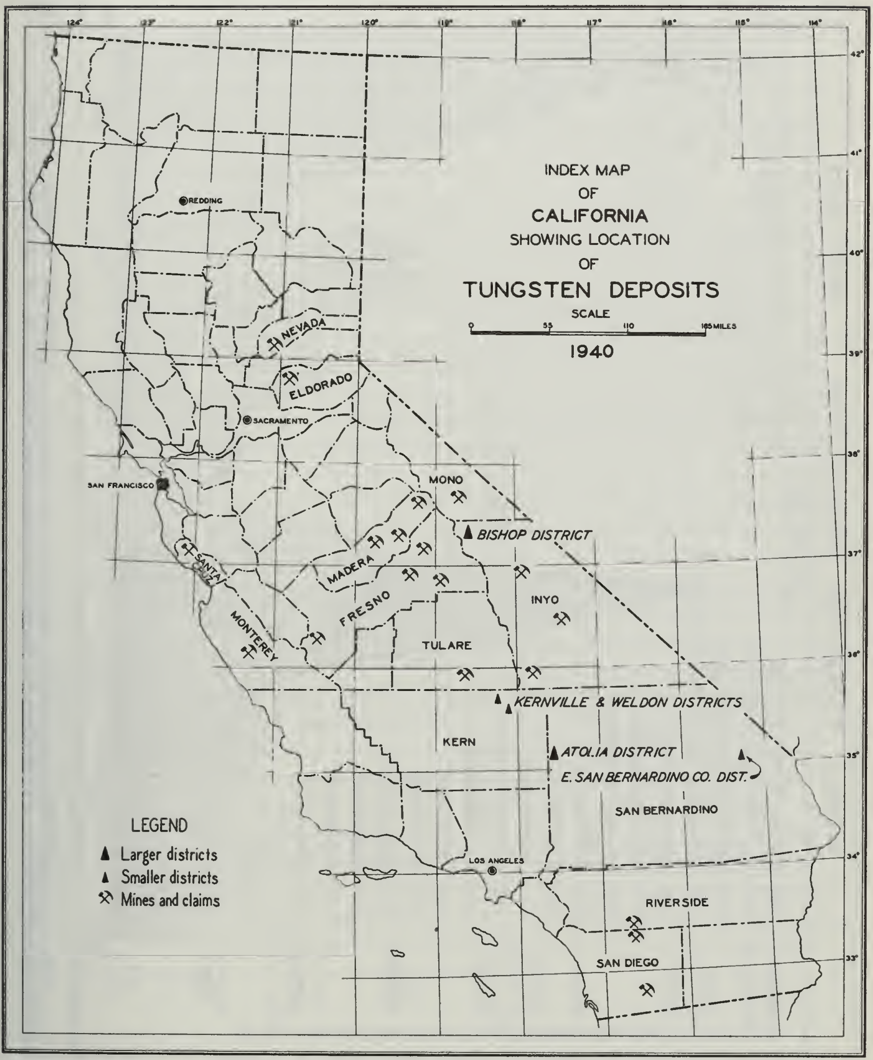
124° 123° 122° 121° 120° 119° 118° 117° 116° 115° 114°
42° 41° 40° 39° 38° 37° 36° 35° 34° 33°
INDEX MAP
OF
CALIFORNIA
SHOWING LOCATION
OF
TUNGSTEN DEPOSITS
SCALE
0 55 110 165 MILES
1940
REDDING
NEVADA
ELDORADO
SACRAMENTO
SAN FRANCISCO
SANTA CRUZ
MONTEREY
MONO
BISHOP DISTRICT
MADERA
FRESNO
INYO
TULARE
KERNVILLE & WELDON DISTRICTS
KERN
ATOLIA DISTRICT
E. SAN BERNARDINO CO. DIST.
SAN BERNARDINO
LOS ANGELES
RIVERSIDE
SAN DIEGO
LEGEND
▲ Larger districts
▲ Smaller districts
⚒ Mines and claims

Fig. 1. Index map of California showing location of tungsten mining districts, and counties in which known tungsten deposits occur.

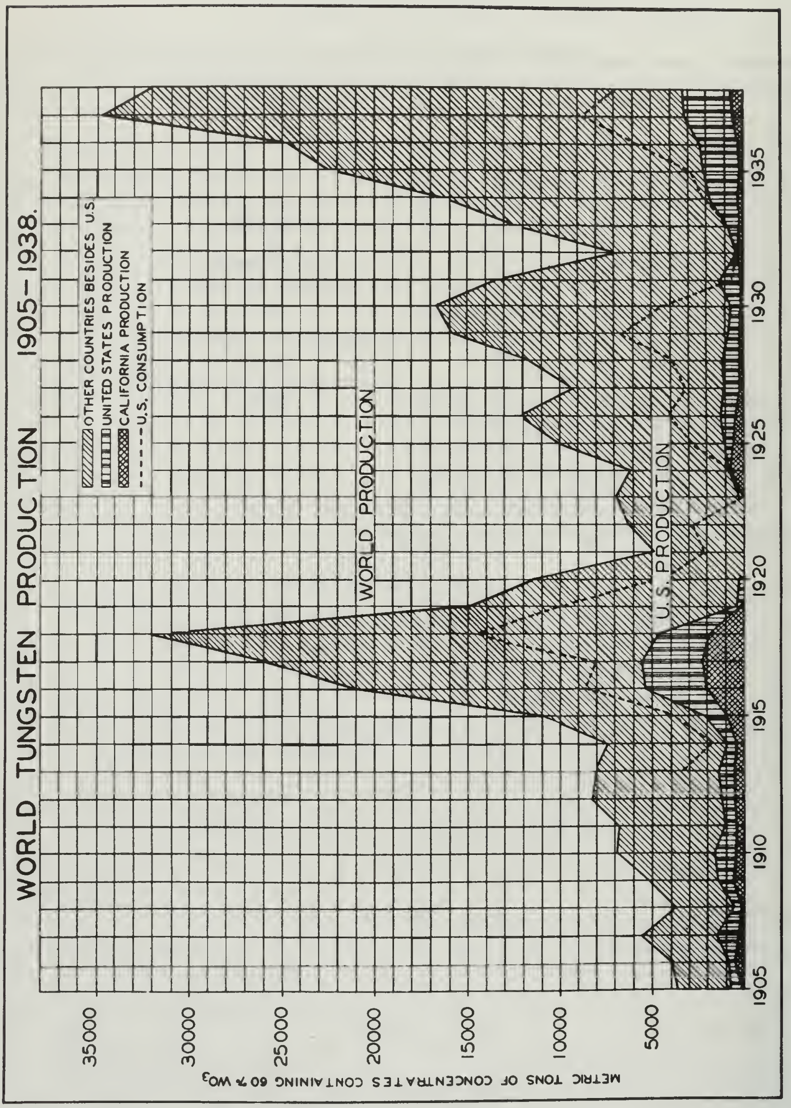

FIG. 2. Graph showing relative importance of tungsten production: WORLD, UNITED STATES, AND CALIFORNIA. *Production* is compared with *consumption* of tungsten by United States.

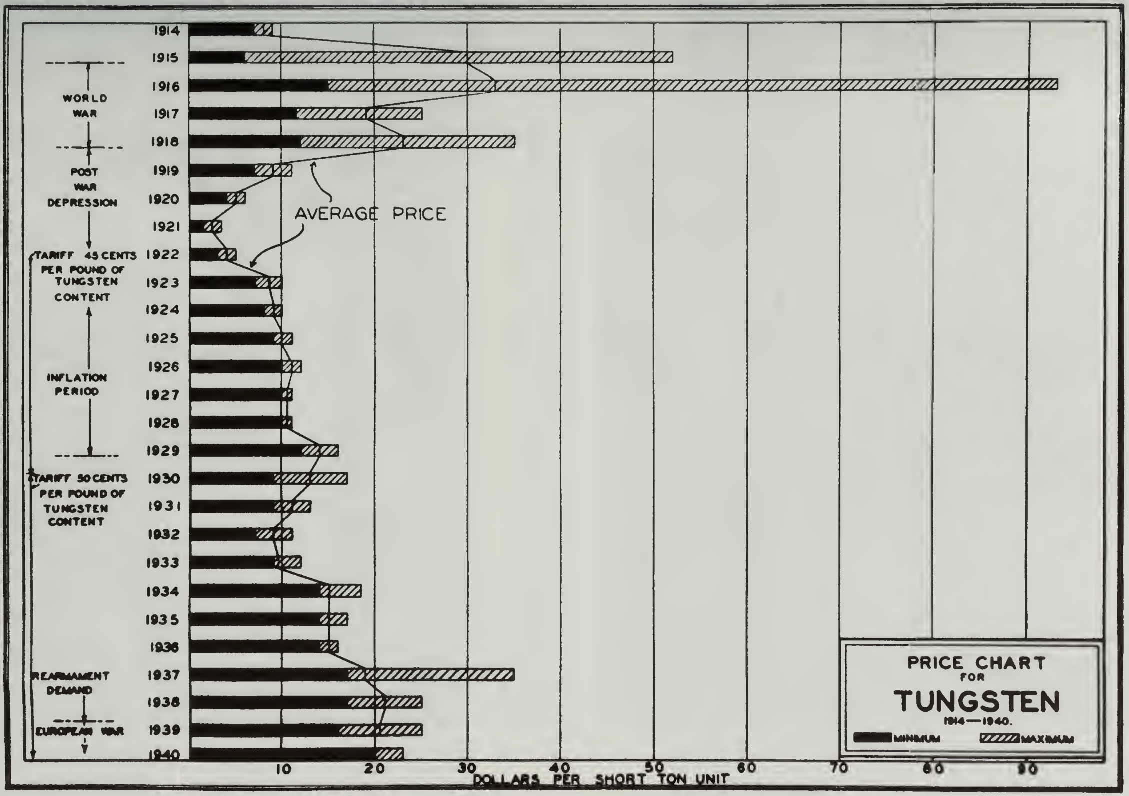

FIG. 3. Chart showing fluctuations in *price* as affected by war, war scares, rearmament demands, and general economic conditions.

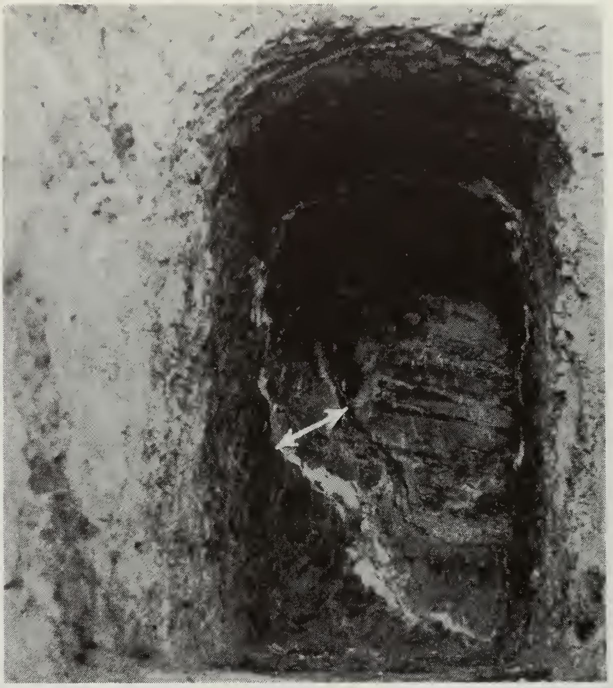

FIG. 4a. Short tunnel on Stanford claim showing contact vein between limestone hanging wall and granite footwall. Width of vein is indicated by arrow. United Tungsten Company, San Bernardino County. *Photo by C. A. Waring (1917).*

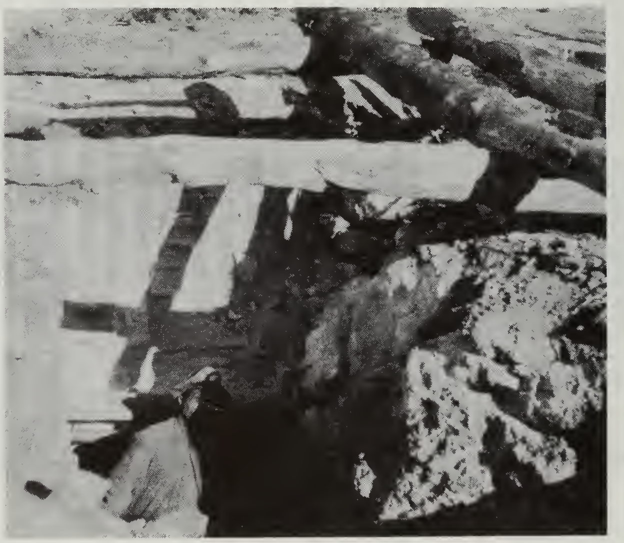

FIG. 4b. Rex shaft of United Tungsten Copper Company, showing 3-foot vein between limestone hanging wall and granite footwall. *Photo by C. A. Waring (1917).*

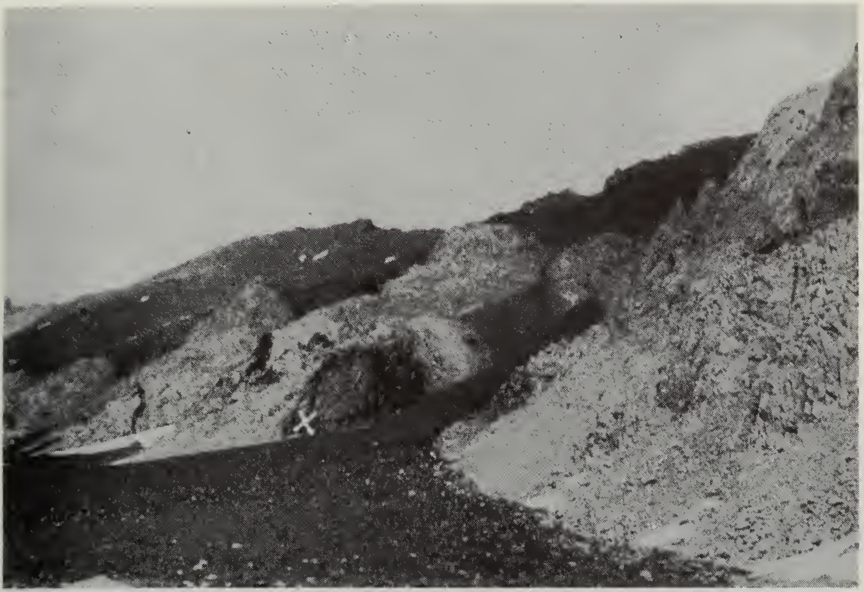

FIG. 5a. View of outcrop at Pine Creek Tungsten mine, Inyo County. Location of tunnel indicated by x. *Photo by C. A. Waring (1917).*

FIG. 5b. High Sierra, looking south from Pine Creek Tungsten mine, Inyo County. *Photo by C. A. Waring (1917).*

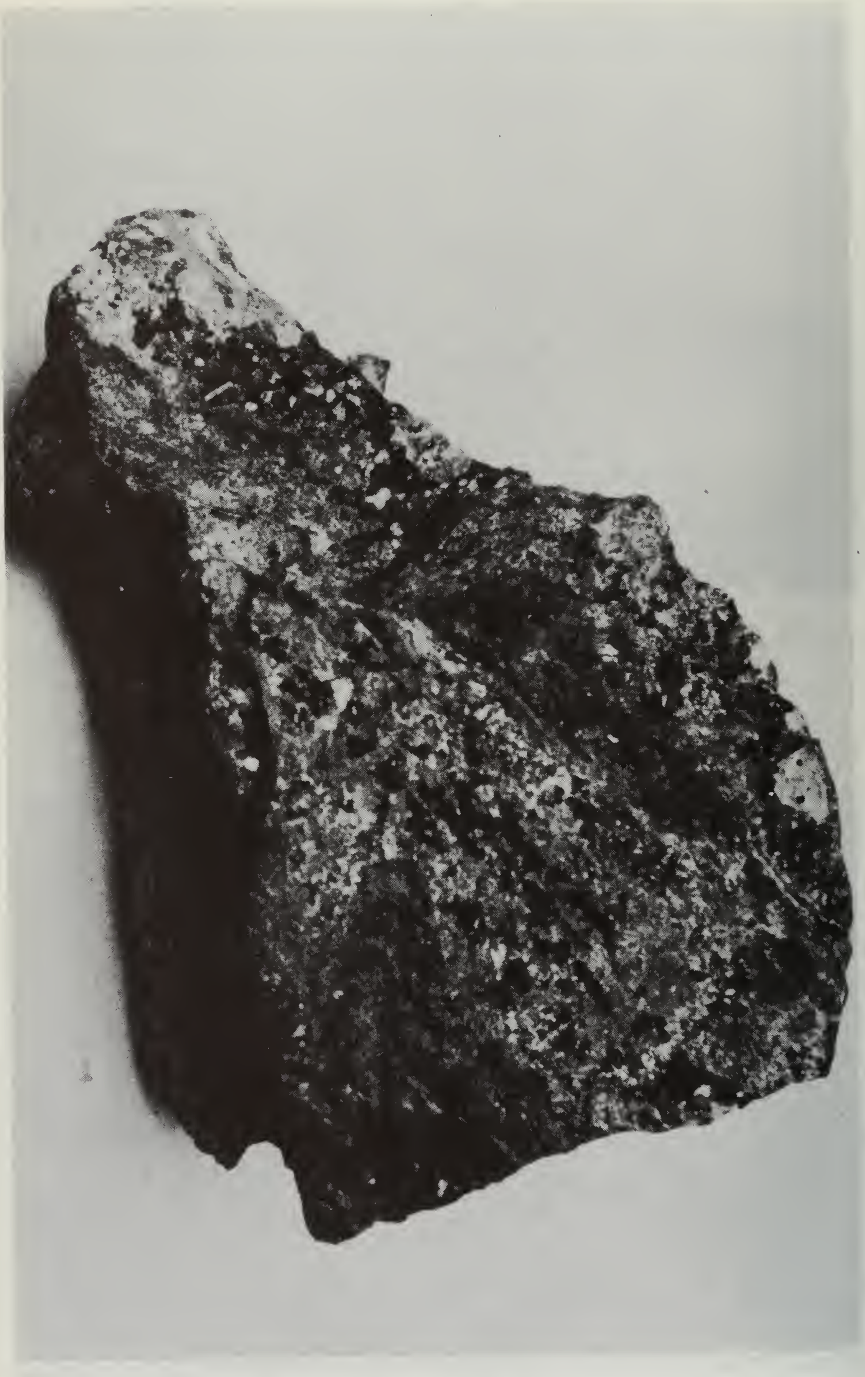

FIG. 6. Garnet-epidote-scheelite ore. Photographed in ordinary light. The scheelite is not distinguishable from the quartz and calcite, as it is the same color, and the cleavage is not discernible.

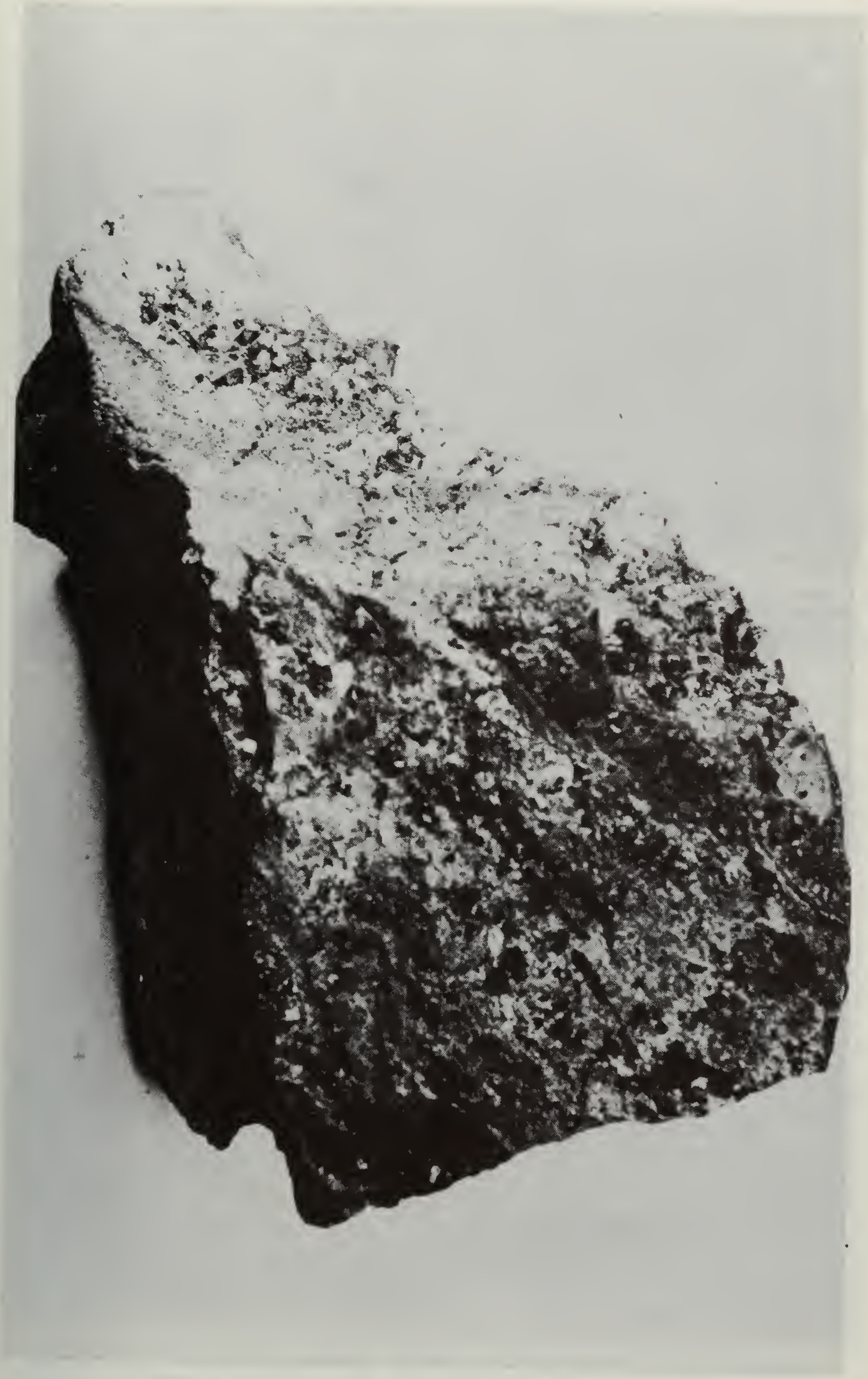

FIG. 7. Same specimen as Figure 6, photographed under ultra-violet light. The scheelite is the light-colored mineral at the upper end of the specimen.

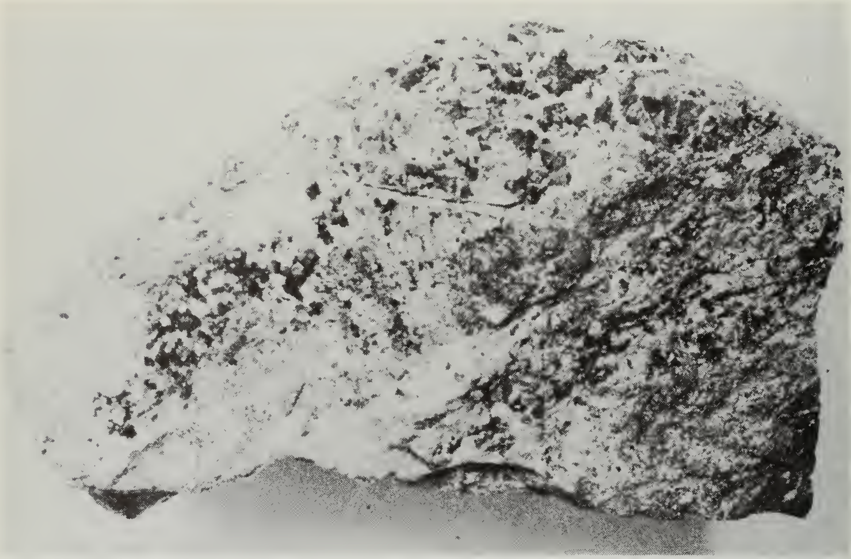

FIG. 8. Specimen from dark-silicate zone, Good Hope mine, near Kernville. Composed primarily of garnet, epidote, and amphibole (probably hornblende), quartz, scheelite, and calcite. The scheelite can be seen as small round grains disseminated in the black amphibole matrix.

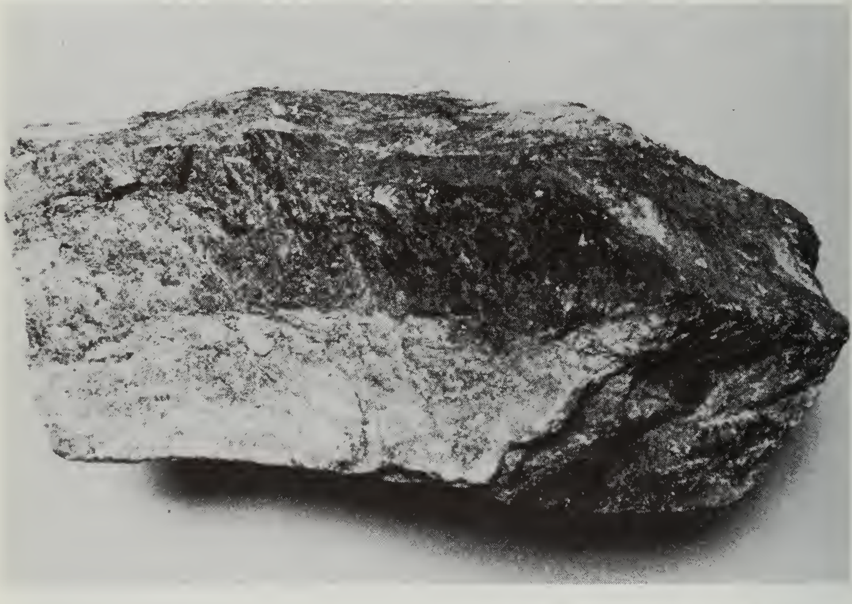

FIG. 9. Specimen from the light-silicate marble contact, Shadow Mountain tungsten mine, in the Mojave Desert, about 20 miles northwest of Adelanto. Specimen shows the rather sharp contrast between the light-silicate zone and the marble zone of a contact-metamorphic deposit.

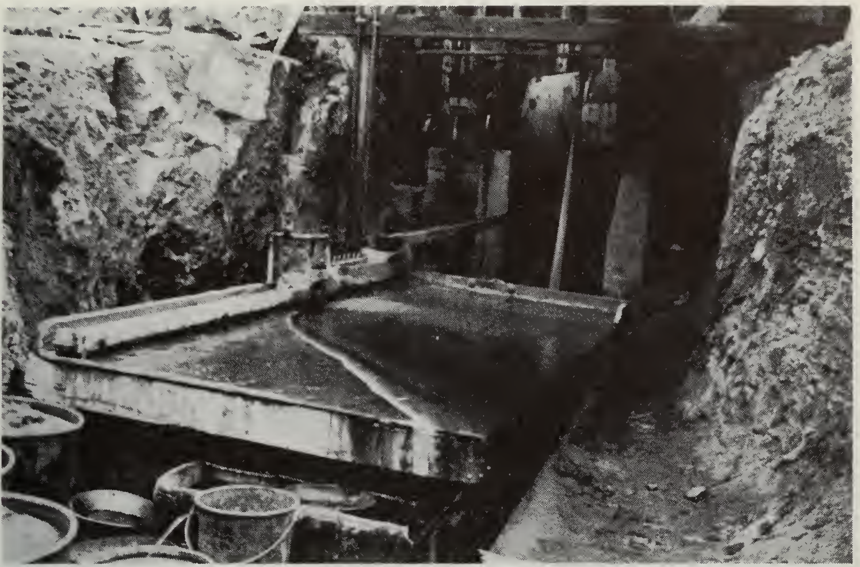

FIG. 10. Vibrating table at Good Hope mine, Kernville, showing white streak of scheelite coming off the end of the table. It grades off into a garnet-epidote milling product. The table is used in a small mill treating a garnet-epidote rock which assays approximately 1 percent WO_3. Photograph taken March, 1940. (See Figures 8 and 20.)

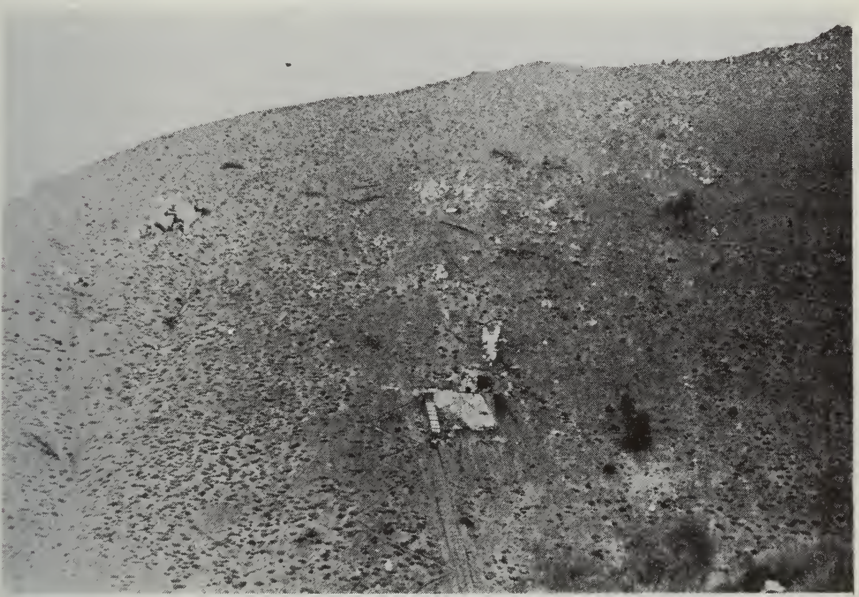

FIG. 11. Tungsten King mine, on the slope of Bald Mountain, eastern San Bernardino County. The outcrops of massive white quartz are on the main vein, which traverses the hill from right to left. Photograph, looking west, taken March, 1940.

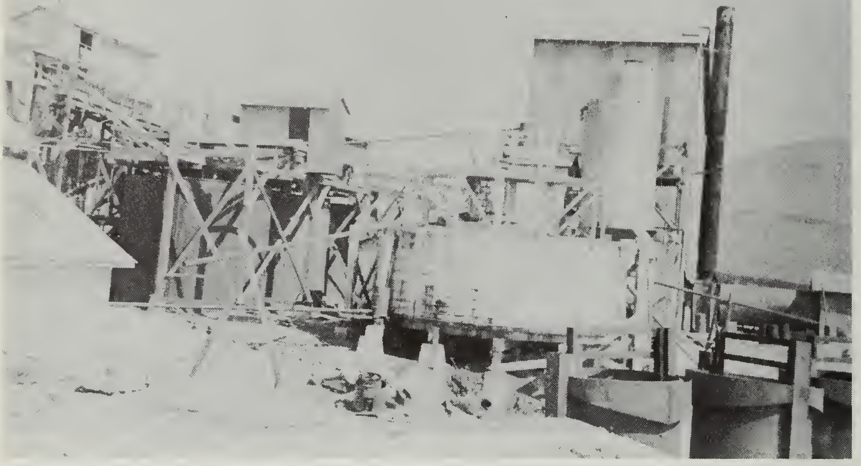

FIG. 12. Leaching plant of the Atolia Mining Company. The three dark tanks, left center, are the leaching tanks. The thickener is in the right center; the dryer tower in the right background, and the dryer furnace and firing house at the extreme right. Photograph taken March, 1940.

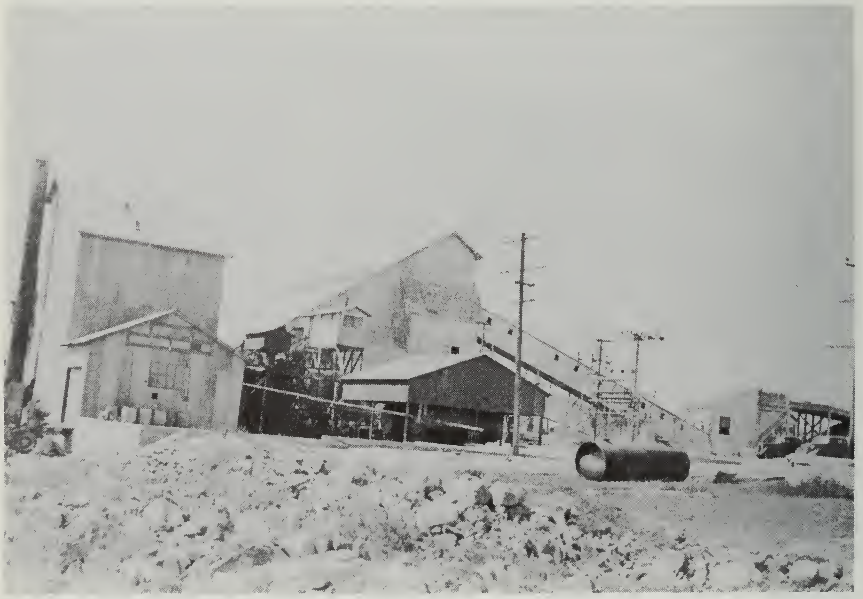

FIG. 13. Mill of the Atolia Mining Company, showing conveyor belt leading to the ore bins. The dryer tower is to the left. Photograph taken March, 1940.

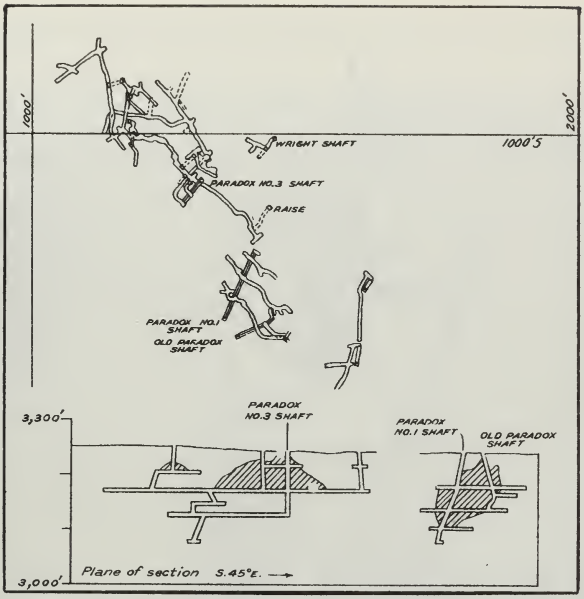
1000'
2000'
WRIGHT SHAFT
1000'S
PARADOX NO.3 SHAFT
RAISE
PARADOX NO.1 SHAFT
OLD PARADOX SHAFT
3,300'
PARADOX NO.3 SHAFT
PARADOX NO.1 SHAFT
OLD PARADOX SHAFT
Plane of section S.45°E. →
3,000'

FIG. 14. Atolia district: plan and sections of Paradox shaft. *Taken from* U. S. Geological Survey Bulletin 922, plate 36 (Lemmon and Dorr 40).

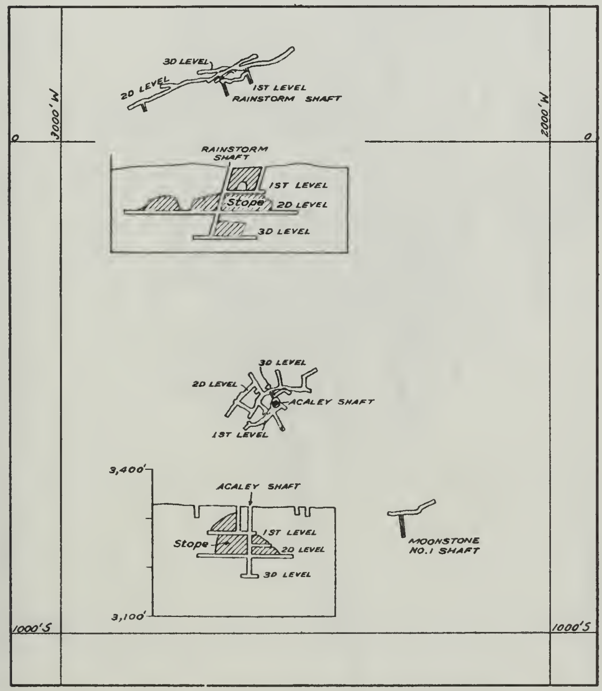
3D LEVEL
2D LEVEL
1ST LEVEL
RAINSTORM SHAFT
0
3000'W
2000'W
0
RAINSTORM SHAFT
1ST LEVEL
Stope
2D LEVEL
3D LEVEL
3D LEVEL
2D LEVEL
ACALEY SHAFT
1ST LEVEL
3,400'
ACALEY SHAFT
1ST LEVEL
Stope
2D LEVEL
3D LEVEL
MOONSTONE NO.1 SHAFT
3,100'
1000'S
1000'S

FIG. 15. Atolia district: plan and sections of Rainstorm shaft and Acaley shaft. *Taken from* U. S. Geological Survey Bulletin 922, plate 36 (Lemmon and Dorr 40).

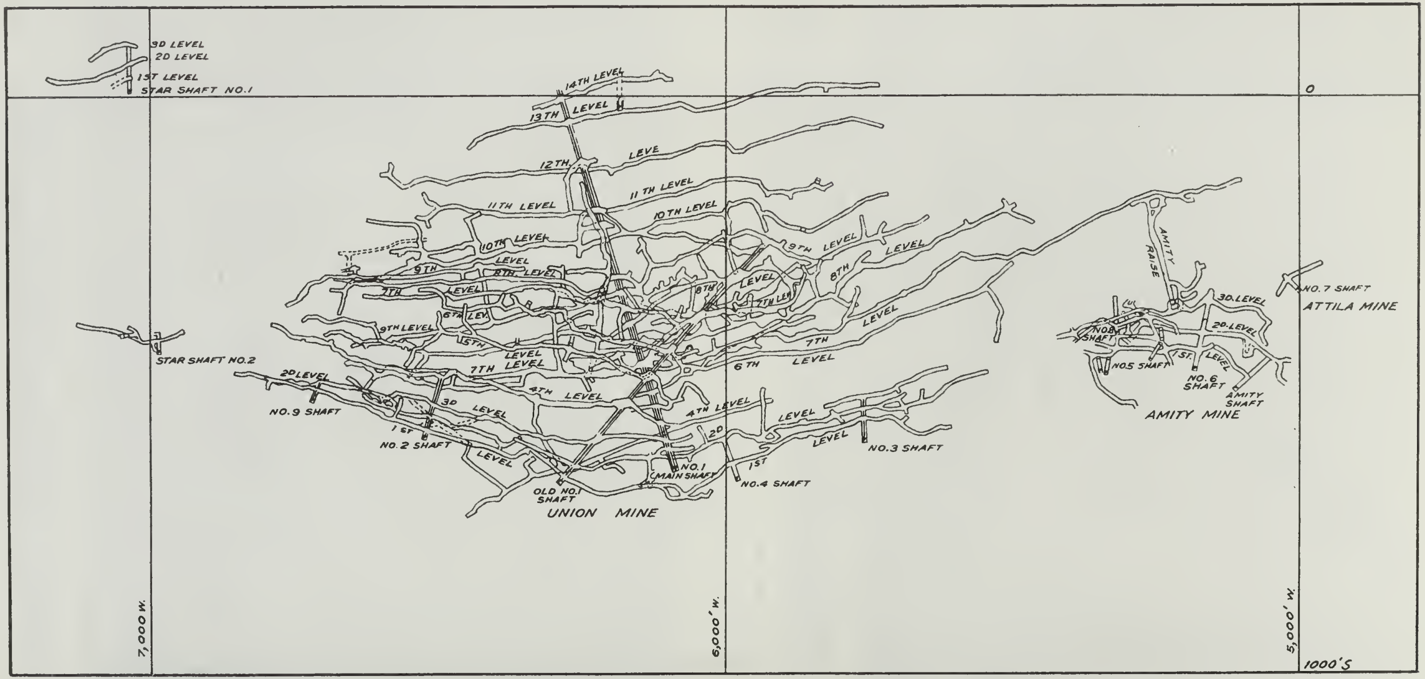
3D LEVEL
2D LEVEL
1ST LEVEL
STAR SHAFT NO.1
14TH LEVEL
13TH LEVEL
12TH
LEVE
11TH LEVEL
11 TH LEVEL
10TH LEVEL
10TH LEVEL
9TH
LEVEL
8TH LEVEL
7TH
LEVEL
6TH LEV
9TH LEVEL
5TH
LEVEL
7TH LEVEL
8TH
LEVEL
7TH LEV
9TH LEVEL
8TH
LEVEL
7TH
LEVEL
6 TH
LEVEL
4TH LEVEL
4TH LEVEL
2D
LEVEL
LEVEL
3D LEVEL
1 ST
LEVEL
1ST
STAR SHAFT NO.2
2D LEVEL
NO.9 SHAFT
NO.2 SHAFT
OLD NO.1 SHAFT
NO.1 MAIN SHAFT
NO.4 SHAFT
NO.3 SHAFT
UNION MINE
AMITY RAISE
NO.8 SHAFT
3D LEVEL
2D LEVEL
1ST LEVEL
NO.5 SHAFT
NO.6 SHAFT
AMITY SHAFT
AMITY MINE
NO.7 SHAFT
ATTILA MINE
0
7,000 W.
6,000' W.
5,000' W.
1000'S

FIG. 16. Atolia district: plan of the Union mine, South vein. *Taken from* U. S. Geological Survey Bulletin 922, plate 36 (Lemmon and Dorr 40).

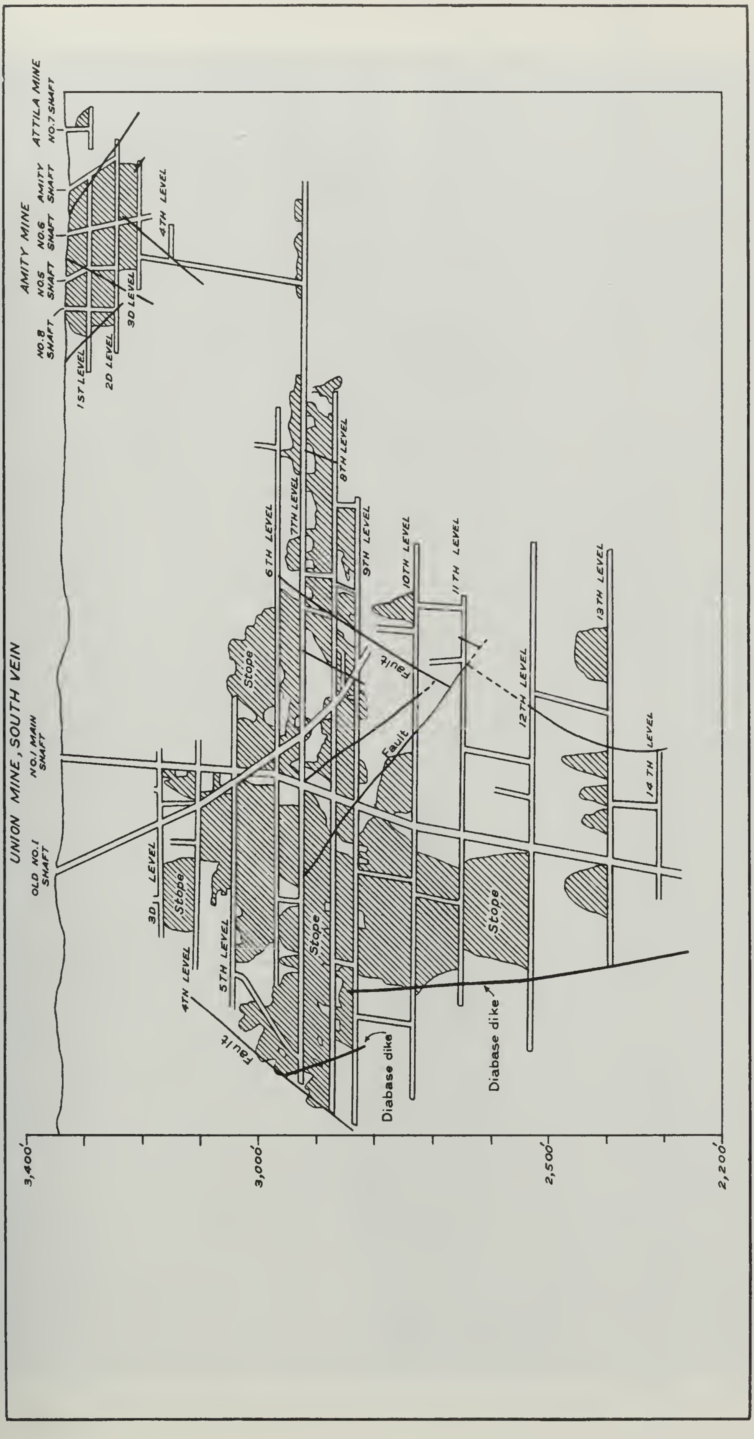
UNION MINE, SOUTH VEIN
OLD NO. 1 SHAFT
NO. 1 MAIN SHAFT
AMITY MINE
ATTILA MINE
NO. 7 SHAFT
AMITY SHAFT
NO. 6 SHAFT
NO. 5 SHAFT
NO. 8 SHAFT
1ST LEVEL
2D LEVEL
3D LEVEL
4TH LEVEL
3D LEVEL
4TH LEVEL
5TH LEVEL
6TH LEVEL
7TH LEVEL
8TH LEVEL
9TH LEVEL
10TH LEVEL
11 TH LEVEL
12TH LEVEL
13TH LEVEL
14 TH LEVEL
Stope
Stope
Stope
Stope
Fault
Fault
Fault
Diabase dike
Diabase dike
3,400'
3,000'
2,500'
2,200'

FIG. 17. Atolia district: cross-section, Union mine, South vein. *Taken from* U. S. Geological Survey Bulletin 922, plate 36 (Lemmon and Dorr 40).

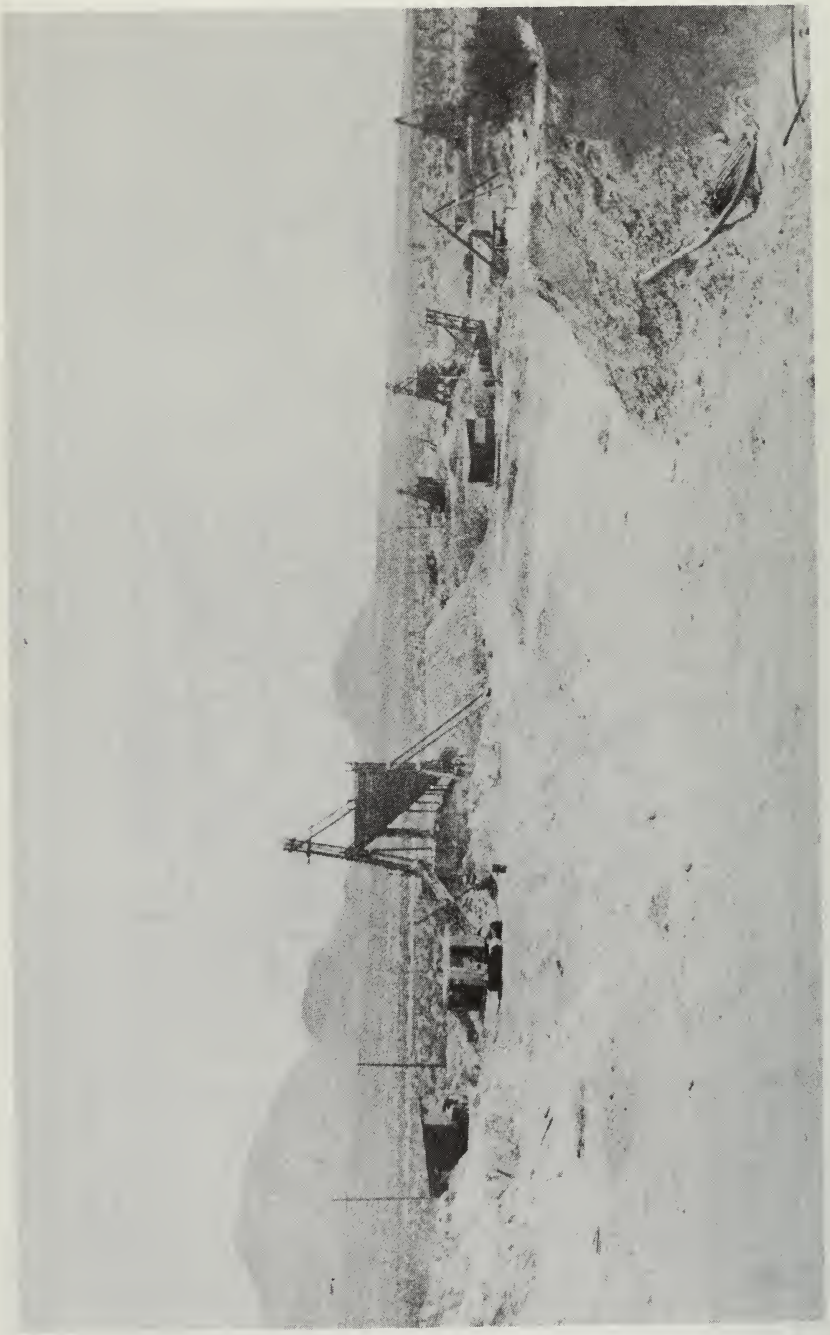

FIG. 18. Shafts at the eastern end of the Atolia Mining Company properties. Photograph taken March, 1940.

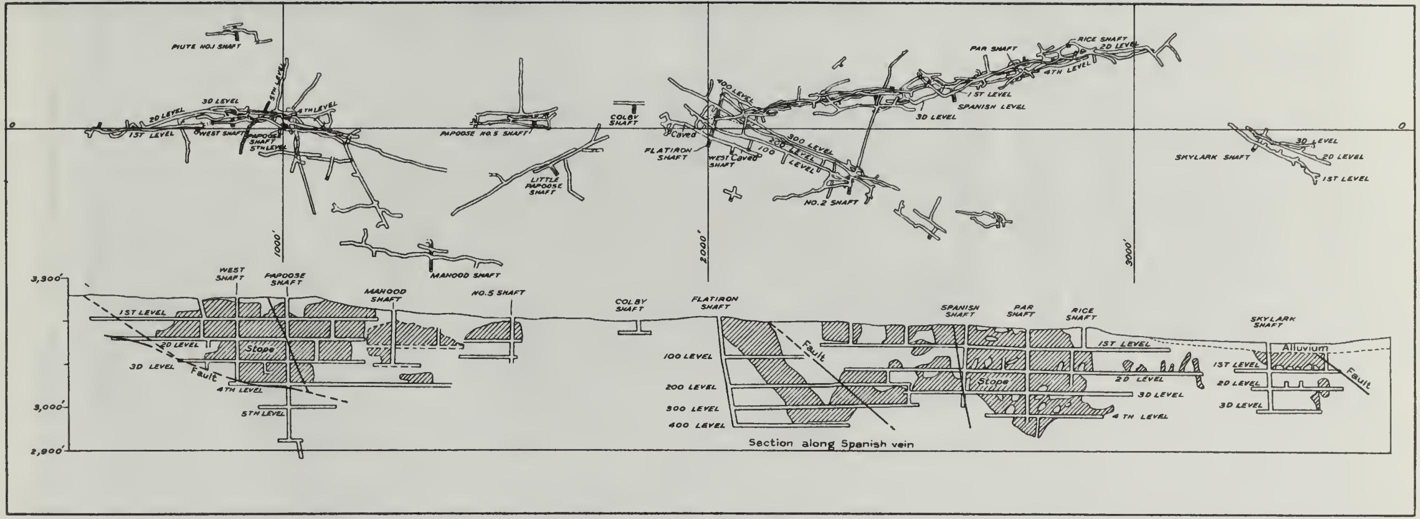
PIUTE NO.1 SHAFT
30 LEVEL
20 LEVEL
1ST LEVEL
WEST SHAFT
PAPOOSE SHAFT
5TH LEVEL
4TH LEVEL
PAPOOSE NO.5 SHAFT
LITTLE PAPOOSE SHAFT
MAHOOD SHAFT
COLBY SHAFT
FLATIRON SHAFT
Caved
WEST SHAFT
400 LEVEL
300 LEVEL
200 LEVEL
100 LEVEL
NO.2 SHAFT
PAR SHAFT
RICE SHAFT
20 LEVEL
4TH LEVEL
1 ST LEVEL
SPANISH LEVEL
3D LEVEL
SKYLARK SHAFT
3D LEVEL
2D LEVEL
1ST LEVEL
0
1000'
2000'
3000'
0
3,300'
3,000'
2,900'
WEST SHAFT
PAPOOSE SHAFT
MAHOOD SHAFT
NO.5 SHAFT
COLBY SHAFT
FLATIRON SHAFT
SPANISH SHAFT
PAR SHAFT
RICE SHAFT
SKYLARK SHAFT
1ST LEVEL
2D LEVEL
3D LEVEL
Stope
Fault
4TH LEVEL
5TH LEVEL
100 LEVEL
200 LEVEL
300 LEVEL
400 LEVEL
Fault
Stope
1ST LEVEL
2D LEVEL
3D LEVEL
4 TH LEVEL
Alluvium
1ST LEVEL
2D LEVEL
3D LEVEL
Fault
Section along Spanish vein

FIG. 19. Atolia district: plan and section of Papoose, Flatiron, Spanish, and Skylark shafts. *Taken from* U. S. Geological Survey Bulletin 922, plate 36 (Lemmon and Dorr 40).

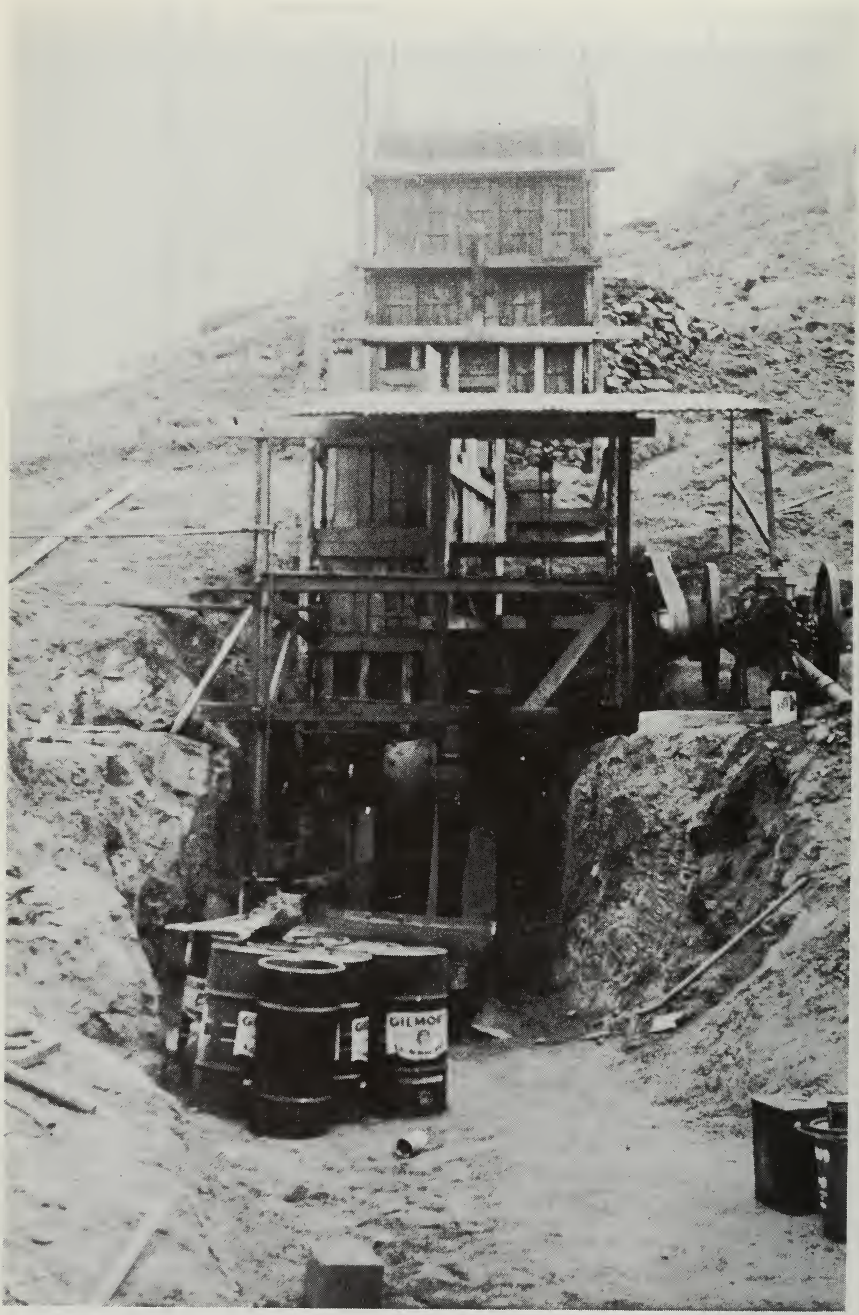

FIG. 20. Mill at the Good Hope Mine, Kernville district. Photograph taken March, 1940. (See Figures 8 and 10.)

presence of deposits in the intrusive rock. These deposits must have been formed after the cooling was sufficient to allow fissures to develop in the crystallized rock. If the rock had not been consolidated, flowage would have taken place rather than fissuring. These deposits, then, in the intrusive rock itself can not be expected to continue to depth.

The solutions are made up chiefly of water carrying silica and other salts. It is believed that the metallic elements are carried in chemical combination with mineralizers such as fluorine, boron, and chlorine, both in solution and in a gaseous state. As these solutions are cooled by the adjacent cooler rock and as the pressure is relieved, crystallization begins. Some minerals crystallize at higher temperature and pressure than others, hence we get the transition from one type of deposit to another. Some minerals, being more volatile, travel farther and are thus found in different environs. Chemical reaction also takes place between the solution and the wall rock, and a certain amount of replacement occurs. Some rocks are more easily replaced than others, especially limestones, which are frequently completely altered.

The pyrometasomatic deposits are a direct result of igneous intrusion. The rocks intruded by the igneous magma are completely or partially altered or replaced by material emanating from the magma. These emanations find their way along cracks and fissures to the easily soluble rock.

They displace certain molecules and radicals, forming new minerals. Often, where there are either no emanations or no fissures to carry emanations, recrystallization takes place with no development of new minerals.

The tungsten salts and compounds have a greater range of crystallization than most minerals, hence the greater variety of types of tungsten deposits. The minerals of the isomorphous series of wolframite, ferberite, and hübnerite are found in pegmatites, the high-temperature quartz veins, and in veins which are generally assumed to be of the intermediate and low-temperature type. Scheelite is found also over this range, but more commonly in the lower-temperature groups. The tungsten is probably introduced as WO_3, and then combines with either Ca, Fe, or Mn to form the various tungstates. Minerals indicative of the presence of mineralizers, such as topaz, tourmaline, and fluorite are often found in intimate association with tungsten minerals. Nevertheless, it is highly improbable that tungsten is introduced in chemical combination with a mineralizer, for the tungsten-bearing minerals are often found in large deposits where there are no signs of mineralizers. The common metallic minerals which are frequently associated with tungsten are: magnetite, limonite, hematite, pyrite, chalcopyrite, arsenopyrite, molybdenite, stibnite, tetrahedrite, bornite, sphalerite, galena, and cassiterite. Common non-metallic associates are: quartz, calcite, siderite, tourmaline fluorite, topaz, feldspar, opal, chalcedony, garnet, epidote, pyroxene, and typical contact-metamorphic minerals.

With this background of the nature of the formation of the typical tungsten deposits, we may attempt to classify the various types. The basis of this classification will be the physical nature of the deposit rather than the mineralogy, method of formation, or temperature.

- A. Placer deposits
  - 1. Wolframite
  - 2. Scheelite
- B. Contact-metamorphic (pyrometasomatic) deposits
- C. Vein deposits
  - 1. Pegmatite
  - 2. Cassiterite veins, stockworks
  - 3. Wolframite, ferberite, hübnerite series veins
    - a. Hypothermal
    - b. Mesothermal
    - c. Epithermal
  - 4. Scheelite veins
    - a. Hypothermal
    - b. Mesothermal
    - c. Epithermal

Placer Deposits

Because of their high specific gravity and their ability to resist weathering, wolframite and scheelite are often found in placer deposits. Scheelite does weather slightly to tungstite—a pale-yellow, powdery mineral—and wolframite crystals have been found with pitted faces. Despite this, they are resistant enough to remain after the rock with which they were associated has decayed. They are seldom transported far, and are nearly always angular because of their friable character.

Wolframite Placers

Wolframite placers are common, but few are of economic importance. The Chinese deposits, however, constitute the largest single source of tungsten in the world. Very little is known of these deposits. In Burma and the Malay States, wolframite is associated with the cassiterite placers, but it usually is so near the outcrop as to be practically a residual deposit. In the lowlands where the majority of the tin is recovered, there is practically no wolframite to be found.

Scheelite Placers

Scheelite is found as small grains in transported placer deposits and in large, angular masses in residual deposits. The only commercial deposit is that at Atolia, where pieces weighing up to 100 pounds were found in a loose, sandy matrix. These pieces were found almost in place, and are the result of the weathering of the granite in which the scheelite occurs. The ore was picked from the surface, dug like potatoes in the sandy alluvium, and concentrated by dry methods from the sand. Because of the characteristic occurrences of the large fragments, this deposit was known as the ''spud patch.'' In the same district an attempt was made to mine placer scheelite from ancient stream channels, but it proved unprofitable on account of low recovery. The deposit contains some gold, and if that could be recovered, the scheelite could be mined profitably. A lack of water hinders the recovery of the gold.

Placer Deposits as an Aid to Prospecting

Placer scheelite is a valuable prospecting aid in finding deposits in place. The scheelite is found in stream beds below the outcrops and can be traced up the stream by panning operations. The stream above the outcrop will be barren of scheelite. Therefore, when scheelite no longer occurs in the stream bed, the prospector must work up the slope on either side of the stream, panning the soil at regular intervals. Soil carrying scheelite will form a triangular area on the slope. The base of this triangle will lie along the stream and the apex at the outcrop. By careful panning operations and accurate locations of all panning tests, the source of the placer scheelite can be easily and accurately located.

The ultra-violet light has been used in prospecting with even better results. Small amounts of scheelite are easily visible at night under the light, and samples may be examined much more rapidly.*

The sample is taken and placed under the light; if scheelite is present it is readily discerned. The light may also be used on outcrops and the scheelite made to stand out from the other minerals. This method is more rapid than the old method of pulverizing the sample from the outcrop, and then panning the ground rock to discover the scheelite. It does not, however, give as accurate an estimate of the amount of scheelite in the sample as does the panning test.

Vein Deposits

The most interesting and varied deposits are the vein deposits. The pegmatitic occurrences are included in this group because of their close genetic connection with the veins. Wolframite, ferberite, hübnerite, and scheelite are all found in veins ranging from the pneumatolytic pegmatitic types to the epithermal hübnerite and scheelite types. Wolframite is found only in the high-temperature deposits, ferberite in the hypothermal and mesothermal, hübnerite in the mesothermal and epithermal, and scheelite throughout the entire series. This variation in occurrence has not been satisfactorily explained, but adequate information is at hand to prove its existence.

Pegmatitic and Hypothermal Vein Deposits

Although the pegmatites do not constitute an important source of tungsten, they do make up a widespread and interesting occurrence. Wolframite occurs with cassiterite in pegmatites as well as in high-temperature tin veins, and in high-temperature wolframite veins, all of which are closely connected geologically. Wolframite is generally deposited farther from the magmatic source than the tin, indicating deposition at a lower temperature and nearer the surface. The zones, however, grade into each other, and cassiterite has been observed deposited on tungsten minerals (Knopf, A. 08). This may be due to a highly heated zone progressing beyond a phase during which the tungsten minerals were deposited.

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* *Editorial note:*

Since many other minerals are visible under ultra-violet light, the presence of tungsten should be checked chemically. Sometimes tungsten-bearing rocks are not detected by the ultra-violet light. The presence of tungsten, however, is readily ascertained by boiling the finely powdered mineral in strong hydrochloric acid; the solution becomes bright yellow and tungstic oxide is precipitated. On the addition of tin, together with boiling, the solution turns a deep blue and later a brown color. See also Heizer, O. F. 38.

Thus, with such conflicting evidence, it is difficult to determine the true nature of the genetic association of cassiterite and wolframite. We do know, however, that the deposits are formed at a high temperature from aqueous solutions which are charged with mineralizers, metallic salts, acids, and silica. Under such conditions a characteristic group of minerals is formed. These mineral associations vary from one deposit to the other; but in general, the same minerals are found together.

Mineralogy. Wolframite and scheelite are the only tungsten minerals found in this type of deposit. Cassiterite is the most important associate. Pyrite, arsenopyrite, chalcopyrite, magnetite, hematite (specular), ilmenite, stibnite, pyrrhotite, sphalerite, galena, and molybdenite are the accessories which are generally found. Gangue minerals are quartz, fluorite, topaz, with occasional rare minerals such as apatite, tourmaline, columbite, spodumene, and beryl. In the pegmatite dikes at the Etta Mine in the Black Hills and at Ivigtut, Greenland, is found a wide variety of minerals which indicate a pneumatolytic origin with fluorine, boron, and chlorine as mineralizers. These deposits are worked for other minerals than tungsten, however, and do not form a source of tungsten.

A detailed study of the tungsten deposits of Burma (Campbell, J. M. 20) will help to clarify further this type of deposit.

Burma Deposits. These deposits are veins in a schist which has been intruded by a very acidic granite of uniform composition. It contains abundant quartz, less feldspar (orthoclase and microcline), very little biotite, no hornblende, and the usual accessory minerals. The ores are not found in the strongly metamorphosed area, but are usually some hundreds of feet from the contact, where the metamorphism is slight.

The tungsten ore is in veins in the granite near the periphery or in the overlying sediments from the contact to over 600 feet, and probably 1,000 feet or more, vertically above the contact. In the granite, three types of ore are found: (1) as primary minerals; (2) in greisen; (3) in veins of quartz, quartz with mica, and pegmatite.

The greisen is a quartz-muscovite rock resulting from the alteration of the acidic granitic intrusive. The feldspars are altered to large mica crystals, and the quartz is apparently unaffected. The greisen is developed only along the walls of fissures, and its presence is proof that the ore-bearing solutions must have come from the interior of the intrusive mass after the outer periphery had cooled sufficiently to crystallize, and to be firm enough to fissure rather than to flow. The greisen is not ore-bearing unless the vein filling of the fissure is also; therefore greisenization must have been connected with the ore-bearing solutions. The ore in the schists is found associated with aplite dikes and quartz veins, again showing a close genetic connection with the acidic intrusive. The quartz veins resemble the pegmatites closely as they always carry some mica, and the pegmatites are noticeably free from feldspars.

That the ore deposition in these deposits is dependent upon the structure produced by the fissuring is evidenced by the extent of the orebodies. The veins occur in groups parallel to one another, in strictly circumscribed areas. Outside of these areas no ore is to be found, and likewise no evidence of fissuring.

Wolframite is the most prominent tungsten mineral. Scheelite is also present, and always found with wolframite. That scheelite is developed at a lower temperature is indicated by the fact that where cassiterite is absent, wolframite and scheelite are intimately intergrown; but where cassiterite is present, scheelite is usually absent. Fluorite and topaz are widely disseminated in the veins, although they are not present in large quantities. Tourmaline and columbite are not present. Pyrite, molybdenite, and bismuthinite, are the common sulphides. The molybdenite is found near the lower limit of the veins, below the wolframite zone. Arsenopyrite, chalcopyrite, magnetite, specular hematite, ilmenite, stibnite, pyrrhotite, sphalerite, galena, and siderite are present in small amounts; but they appear to have been deposited in reopenings of the fissures long after the tungsten was introduced.

Molybdenite is generally the first mineral deposited, and is closely associated with mica; the two are evidently paragenetic. Wolframite follows, often enclosing both the molybdenite and the mica. The common occurrence is in groups of divergent crystals. The interspaces are filled with pyrite, cassiterite, scheelite, and quartz. Pyrite and cassiterite sometimes develop simultaneously with wolframite, but never precede it. The tungstates are generally in large crystals; never in minute crystals. Wolframite crystals are usually bladed, and run into each other for several feet along the vein. Acicular forms are also found.

The tungsten deposits appear to be a result of magmatic differentiation. After the magma had consolidated, they formed from the residual aqueous solutions, which were highly saturated with mineralizers and metallic salts.

Mesothermal and Epithermal Deposits

More important are the medium and lower temperature quartz veins. Wolframite, ferberite, hübnerite, and scheelite are the tungsten minerals; all are of equal importance. The deposits are of the true fissure type, and usually are closely associated with gold-quartz deposits. In this class there is a wide variation, from wolframite veins containing tourmaline and fluorite, indicating formation at a high temperature, to hübnerite veins containing crustified and comb quartz, indicating formation at a very low temperature.

Mineralogy. The ore is disseminated or in bunches of massive mineral in crystalline, glassy, vein quartz. The deposits usually contain sulphide minerals such as pyrite, chalcopyrite, sphalerite, galena, and some of the more complex sulpho-salts. The most common gangue mineral is quartz, although in some instances calcite, fluorite, adularia, and siderite form the gangue.

Structure. These deposits are always associated with intrusive bodies of an acidic, granitic character, and are found either in the intrusive body itself or in the adjacent metamorphic rocks into which the granitic rock is intruded. The original magma of the intrusive, upon cooling, gives off aqueous solutions charged with tungstic acid and silica. The tungstic acid combines with either ferric iron, manganese, or calcium (depending upon the element present) to form the various tungstates. These deposits are all formed along zones of active fissuring. The fissures often have several periods of activity, and the solutions are introduced during one or two of these periods.

Slickensides, gouge, and breccia are common along these veins. Gold and silver are seldom found in the same vein with tungsten minerals, but are frequently found in adjacent veins of a similar character. This is especially true at Atolia and in Boulder County, Colorado. Combs and druses are often found, indicating low temperature and pressure at the time of deposition. Hulin (25), in studying the rich scheelite veins at Atolia, decided that they were formed during Miocene time, in connection with nearby volcanic activity, and not during the period of the intrusion of the granite in which the deposits occur, as was previously supposed.

Boulder County Deposits. The gold and tungsten deposits of Colorado, described by Lindgren (07, p. 111) and Hess and Schaller (14), are typical of the mesothermal vein types. The tungsten mineral is ferberite intimately associated with quartz in brecciated veins in granite, which is intruded into pre-Cambrian gneisses and schists. Some wolframite is present. Scheelite is developed on the surface of some of the ferberite crystals. Extensive shattering has taken place after the deposition of the tungsten minerals, and has been followed by silicification. Quartz is the main gangue mineral, and some fluorite is present. The country rock is strongly sericitized and, in some places, silicified adjacent to the vein.

The vein filling is quite different from the nearby telluride veins, but there is a strong resemblance between them in structure and in sericitization of the country rock. These deposits are believed to be of recent thermal origin, and to have been deposited at a moderate depth.

Zaca Mine Deposit. Epithermal hübnerite was found at the Zaca mine in Alpine County, California (Gianella, V. P. 38, p. 339). The ore is in small fissures, lenses, and irregular masses in rhyolite. The gangue minerals are a dense stony quartz, granular and crystalline quartz, rhodochrosite, and calcite. Ore minerals are pyrite, galena, sphalerite, argentite, stephanite, tetrahedrite, and hübnerite. The ore is typical bonanza, with rhythmic deposition, three generations of quartz, and two of rhodochrosite.

The hübnerite encrusts the other minerals, is found in cavities within the stony quartz, and is in quartz or rhodochrosite veinlets that penetrate the granular quartz or cut the unreplaced wall rock. The crystals are prismatic in form, and are arranged in both radiating and parallel groups. The euhedral crystals and the encrusting nature give good evidence of the late introduction of the hübnerite.

Atolia Deposits. The scheelite-bearing veins at Atolia, described by Hulin (25, p. 70), and more recently by Lemmon (Lemmon and Dorr 40), form one of the largest scheelite deposits in the world. The scheelite occurs in a series of fissure veins, cutting quartz monzonite along a zone of shearing or fracturing. These veins strike N. 75° E. to N. 75° W., and dip 45° to 90° N. The veins are roughly parallel and occupy a belt about 2 miles long, which has a general northeasterly trend. The veins are, for the most part, short and irregular, and they unite or branch frequently. They are dissected by a series of cross-fractures which are in general not mineralized. The movement along these cross-faults is horizontal and the displacement is small—usually less than 25 feet. Dragged quartz and scheelite in the fault gouge enable the miners to find the offset veins readily (Lemmon and Dorr 40, p. 216). Some of the cross-faults are slightly mineralized, indicating that mineralization continued to some extent after the cross-faulting took place.

Quartz is the chief gangue mineral; carbonates (calcite, ankerite, dolomite, and siderite) are also prominent. Scheelite is the only tungsten-bearing mineral found. Other associates are sporadic pyrite, stibnite, and cinnabar. A pocket of gold ore was found in the Rainstorm vein, while in other veins of the district gold ore is found, but no scheelite.

The scheelite occurs in veinlets and in masses in the larger veins. It is generally impure, being admixed with quartz and calcite, which give it a brownish tinge. It is seldom found in euhedral crystals, but rather in coarse-grained masses which often exhibit large cleavage surfaces (Lemmon and Dorr 40, p. 218).

The quartz occurs in several forms ranging from fine-grained brownish chalcedonic quartz to the pure-white milky variety. The fine-grained variety was apparently deposited first, and the coarser-grained milk quartz last. Comb quartz, and crustification which is symmetrical with respect to the walls of the veins, suggest the epithermal nature of the deposits. Euhedral crystals are often found protruding into cavities where quartz failed to fill the fissures completely (Hulin 25, p. 70).

The carbonates were deposited later in veinlets, cutting the quartz and scheelite, and occupying cavities in the veins. The pyrite is a minor constituent of the veins, but is more abundant in the adjacent altered zone of the quartz monzonite country rock where sericite, kaolin (?), and chlorite are also developed. Stibnite, cinnabar, and gold are minor in occurrence and are present as vein minerals. Phosphorus is present in the ore, probably as apatite in included quartz monzonite, as no phosphate mineral has been isolated in the ore (Lemmon and Dorr 40, p. 218).

The scheelite ore occurs in shoots in the veins. These shoots have the shape of inverted pyramids, being broadest at the top and becoming narrower with depth. They are, for the most part, vertical, but in the eastern part of the district they pitch to the eastward parallel to the cross-faults. A great many of the shoots never reached the surface; exploratory work, as a result, is difficult. Cross-faults and changes in the dip of the vein have had an apparent effect on the deposition of the ore. Although the cross-faults are later than the ore deposition, the stress which caused the fractures must have been present during the deposition of the ore, as the shoots often lie adjacent to the cross-faults, indicating that the incipient stress had a pronounced effect on the solutions and caused the tungsten salts to be deposited in the regions of stress (Lemmon and Dorr 40, p. 222). Swells in the veins and flattening of the veins also had their effect on the ore deposition. The richest orebody in the Union mine was found in the flattened part of the vein, where the thickness of the ore reached a maximum of 17 feet. The veins without exception fall off in value with depth, although few of the mines have mined to the lowest limits of the ore.

The ore has been deposited in open fissures, and little or no replacement of the wall rock has taken place. The quartz and scheelite were deposited simultaneously and continuously, accompanied by movements along the fault. The first material deposited was dense and fine-grained, but gradually increased in size. The coarsest material was deposited last. The quartz outlasted the scheelite, and fractures caused by the later movements were cemented by barren gangue.

The ore originated from heated solutions coming from below, along the fissures. The solutions were probably alkaline and carried silica, lime, carbonic acid, tungstic acid, iron, antimony, sulphur, and traces of mercury, copper, and gold. The vein structure, textures, and mineral assemblage suggest formation close to the surface under conditions of low temperature and pressure, rather than from high temperature conditions and deep-seated mineralization. If the deposits were associated with the batholithic intrusion of the quartz monzonite, deep-seated mineralization, with its characteristic mineral assemblage and coarsely crystalline texture, would have been evident. It is therefore to be assumed from the nature of the ore that the veins were formed at a later time, during the period of volcanic activity which formed the nearby gold and silver deposits. This seems to be proven by the fact that scheelite is found in the adjacent gold veins in small amounts;

and that stibnite, which is found in the veins at Atolia, is also found in large amounts in the nearby silver veins. Since scheelite is the dominant mineral in the pyrometasomatic deposits, which are formed at high temperatures and pressures at great depths, it is readily seen that scheelite crystallizes throughout a great range. In the mesothermal gold-quartz veins of the Grass Valley district, scheelite is an intermediate occurrence in the gangue.

Golconda (Nevada) *Deposit.* (Kerr, P. F. 40)[4] An unusual type of epithermal deposit is the tungsten-manganese deposit at Golconda, Nevada. Tungsten occurs here in a blanket of manganese and iron ores underlying a tufa deposit and overlying a series of steeply dipping metamorphosed sedimentary rocks. No tungsten minerals have been identified, nor have any relic structures of tungsten minerals been found. The tungsten occurs directly in the manganese and iron minerals and is believed to be in the form of adsorbed tungstic acid. The principal ore minerals are psilomelane, hollandite, and limonite.

These deposits are generally believed to be of hot-springs origin. Vertical fissures in the metamorphic rocks which contain tungsten are considered to represent a lower phase of the hot-springs deposits and suggest a hypogene source for the tungsten-bearing solutions. The first phase of the hot-springs action is considered to be silicification, which is represented by the chertification of nearby limestone beds. Then the manganese and tungsten solutions came, and formed the blanket of ore. The final action resulted in the overlying cap of tufa. Some secondary enrichment may be represented in the ocherous layers of the ore blanket, but hypogene solutions rather than supergene solutions seem to have played the major part in the mineralization.

Erosion has resulted in the uncovering of the deeper tungsten-bearing veins, and in some dissection of the remaining spring deposits. The tenor of the ores varies from 6.19 percent in the ocherous layer of the ore blanket to 1.82 percent in the impregnated weathered-shale zone directly below the blanket. The average grade of the ore where it has been carefully sampled and assayed is 2.75 percent WO_3.

Although tungsten has been noted in analyses of manganese deposits for a great many years, this is the first deposit in which economic considerations have been made. It might be well to consider all manganese deposits of this type for tungsten possibilities.

Contact-Metamorphic Deposits

The contact-metamorphic deposits of the Great Basin region of western United States represent an important type of deposit. Although contact-metamorphic deposits are known in Alaska (Bateman, A.M. 18, p. 112) and Finland, the most important orebodies of this type are found in California and Nevada. These deposits are associated with acidic, granitic, intrusive rocks and are generally considered to be of high-temperature, deep-seated origin. They are a replacement type of deposit, hence the name pyrometasomatic. They are similar in appearance, association, and mineral assemblage.

They are formed through the combined action of heat and solutions, emanating from a cooling granitic magma, on the intruded rocks. The intrusive rock itself is frequently altered to a small extent. These rocks are altered to, or replaced by, an aggregate of garnet, epidote, diopside, quartz, calcite, scheelite, and other characteristic minerals. The deposits lie at or very near the contact, and are invariably a replacement of limestone.

The intrusive rocks associated with these deposits are everywhere highly acidic and rarely of intermediate character; without exception, they carry some orthoclase and free quartz. Generally the intrusive rock is a granodiorite; but granite, soda granite, quartz diorite, and quartz-bearing pyroxene diorite are locally associated with deposits. Biotite and hornblende are the principal dark minerals, and titanite is commonly abundant. The ore appears to be associated with the general batholithic intrusion rather than with any certain phase. The sedimentary rocks which make up these deposits are limestones and dolomites which have been either partly or wholly replaced by silicate minerals such as garnet, epidote, pyroxenes, and amphiboles. The deposits may form in thin beds, interbedded with other sedimentary types, as at Mill City, Nevada (Hess and Larsen 22, p. 245), or in beds thousands of feet thick as at Pine Creek near Bishop, California. Not all limestone beds are replaced; in certain instances only a strong recrystallization has taken place.

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[4] This description was inserted by the author after the completion of the paper. Therefore this deposit was not considered in the foregoing classification of tungsten deposits.

Mineralogy—The tungsten deposits are characterized by a more limited and specific mineral assemblage than most contact-metamorphic deposits. Scheelite is the sole tungsten-bearing mineral which occurs in these orebodies. Garnet, diopside, epidote, vesuvianite, hornblende, quartz, calcite, and both potash and magnesia micas are common. Pyrite, chalcopyrite, pyrrhotite, molybdenite, sphalerite, magnetite, hematite, fluorite, and zeolites are present in some deposits. Garnet is the most prominent mineral—generally having a brownish-red color and being of the grossularite or andradite variety. This ore forms a prominent outcrop and generally forms a rim around the main body of altered limestone, the entire limestone rarely being replaced. This type of garnet-rock has been termed ''tactite''.

Structure—The size and shape of these deposits depend upon five factors: (1) size and form of the sedimentary and intrusive rocks; (2) quantity and character of the solutions; (3) presence of fractures in the rock at the time of intrusion; (4) relative susceptibility of the various beds in the intruded rocks, to replacement; and (5) structure of the sedimentary rocks.

The fractures seem to be the most important factor of control, as without them the solutions would have had no access to the mass of rock to be replaced. Solutions, and not heat alone, are the chief agents in bringing about the alteration and replacement. Heat alone results in recrystallization only. The new minerals are developed from added elements and not from the fusion of limestone, silica, and impurities in the limestone, as was believed for many years. There are examples of limestone entirely surrounded by granite, in which no replacement or alteration other than recrystallization of the calcite has taken place, as no fissures were present to introduce the solutions.

The pyrometasomatic deposits are generally arranged in zones of different character, either across the contact or across fractures through which the solutions were admitted. In many cases the following order was found: (1) altered granite; (2) main body of metamorphic material on the limestone side of the contact, dark-silicate zone; (3) light-colored silicate zone; (4) main body of crystalline limestone.

The altered granite zone is generally not so wide as the other zones, and is not present in all deposits. The granite here is more highly siliceous, consisting mostly of quartz and subordinate dark silicates. The dark silicates increase in amount toward the contact, and tend to merge with the next or dark-silicate zone.

The tactite or dark-silicate zone is the one in which the best ore occurs. It is wider than the altered granite zone and, in places, wider than the light-silicate zone. The contacts are generally fairly sharp. The composition and texture of this zone are variable. Garnet is usually the dominant mineral, although occasionally epidote or clinozoisite is dominant. A pyroxene between diopside and hedenbergite (Hess and Larsen 22) is common in some deposits, and in a few places it is more plentiful than epidote. A dark green uralitic hornblende is common, and is one of the chief minerals in some deposits. At one deposit near Glennville, pyrrhotite is the dominant mineral. At Mill City, pyrite is abundant in the deeper workings.

Calcite and quartz are always present in some quantity—calcite usually being more plentiful. Phlogopite, muscovite, and fluorite are abundant in a few deposits. Sphene and apatite are always present. Scheelite is the tungsten mineral, and is disseminated in large grains. It is not always present, however, and the ore occurs in definite shoots within the tactite. Sphalerite, chalcopyrite, molybdenite, galena, bismuthinite, feldspars, zeolites, and chlorite occur in small quantities. Vugs and drusy openings are common, and are formed at the time of metamorphism. They are generally lined with crystals of garnet, epidote, and quartz. The rock is usually brown in color, friable, and is porous.

The zone of light-colored silicates follows after a fairly sharp, distinct contact. It varies in width and grades into marble. The most common silicates are wollastonite and tremolite, followed by colorless diopside, scapolite, alkali feldspar, quartz, and vesuvianite. Colorless garnet is less common, pyrite is rare, and calcite abundant. Hess (Hess and Larsen 22) states that scheelite is unknown; but at Shadow Mountain in the Mojave Desert, and at Kernville, scheelite is present in amounts up to one percent. At Bishop, the rock in this zone is friable and is made up mostly of pale green vesuvianite. In the Kernville and Shadow Mountain districts, this zone is hard and resistant. The rock is composed primarily of gray, crystalline calcite, fine-grained garnet and epidote, and minor amounts of scheelite.

The marble zone varies in size, depending upon the size of the deposit and the degree of alteration and replacement. It contains scattered grains or bunches of silicates of the same type as those in the light-colored zone. These bunches are usually lenticular, follow fissures, and generally carry no scheelite. Quartz veinlets cutting the marble may carry scheelite.

Order of Mineralization. The order of mineralization is somewhat complicated and the relationships are not always clear. Garnet is generally considered to have been deposited first. Diopside is in part contemporaneous and in part somewhat later. Epidote followed and, still later, the sulphides associated with quartz and calcite were deposited, filling cracks and spaces, and forming veins through the minerals. Scheelite was apparently deposited throughout the period of mineralization with the exception, possibly, of the latest stages; it is found intimately associated with garnet, diopside, and epidote. It is also in quartz and calcite veinlets that cut the normal tactite.

Conditions of Mineralization. Heat is not the sole factor in the metamorphism. It is agreed among geologists, however, that a high temperature is needed for the formation of pyrometasomatic tungsten deposits. Solutions emanating from the cooling magma, and open passages for the migration of these solutions are the important factors; mere transfer of heat by conduction is relatively unimportant. The chief work of the solutions is to carry the heat of the magma to the adjoining rock and thus raise the temperature of the adjacent rocks. This removes material from the rocks to be replaced; carries mineral material to the replacement zone, and there deposits it; and brings about recrystallization and rearrangement of the minerals in the contact zone. It is generally believed that the material is removed and deposited simultaneously, and that the loss of volume is in the form of carbon dioxide which escapes through fissures and openings to the groundwater system and thence to the surface. It is not believed that the calcite is dissolved and carried off in aqueous solution. The solutions must have carried much silica, considerable amounts of iron and alumina, some tungsten, phosphorous, titanium, potash; and in places fluorine, chlorine, and other elements; and possibly considerable carbon dioxide.

Tenor of Deposits. These deposits are irregular in size and usually are rather small. They cannot be expected to carry to depth, as the majority are developed in roof pendants which are cut off abruptly by the intrusive rock at depth. Where the bedding is parallel to the longest dimension of the intrusive rock, the deposits are best developed, because of the greater chance for the circulation of the ore-bearing solutions. Fracturing is a strong control and may lead to orebodies, where the host rock is variable in its susceptibility to replacement. The tenor of the ore is generally low, as the scheelite is disseminated and not present in large amounts.

Conclusion

All of these types of deposits are represented in California, with the exception of the ferberite vein deposits which are so well developed in Colorado. The contact-metamorphic deposits are the most widespread and most important in the State. The scheelite vein deposits at Atolia were for a long time the source of the greater part of the tungsten mined in the United States, but they are now being mined only to a limited extent. Wolframite and hübernite veins may be developed to importance, some time in the future. The hypothermal wolframite, wolframite-cassiterite, and pegmatite vein types are merely of geologic interest and are scarce.

ORE DRESSING

The ore minerals of tungsten have always been treated by rather simple methods, which, although they gave a good grade of concentrate, resulted in only a fair recovery. The earlier-discovered deposits were usually of a high grade and losses were not considered important. Now, with the mining of one percent ores and with the discovery of large low-grade orebodies averaging only 0.5 percent WO_3, the ore-dressing methods formerly used are found to be inadequate. A recovery of only 70 to 80 percent of the WO_3 content of the ore means too high a loss, and does not allow these lower grade orebodies to be worked profitably.

The chief difficulty in the treatment of tungsten ores lies in the heavy slime losses. Also, it is found that care must be exercised to prevent shattering, else fines will be in excess. Tungsten minerals are friable and they slime easily during crushing and grinding. In treating low-grade ores, fine crushing must be used to break the tungsten mineral free from the gangue, and the result is a heavy sliming of the tungsten minerals. Until a method can be found to recover the tungsten from the slimes, the mining of tungsten in the United States will be retarded.

Methods of Treating Tungston Ores

Hand-Sorting

In the earliest days of tungsten mining, hand-sorting was the only concentration method used. Wolframite and ferberite were the chief minerals mined, and were easily separated from the gangue. The deposits were of high grade, with large crystals and masses of the ore minerals. They were dark in color, heavy in weight, were cobbed and sacked with little difficulty and at low cost. In the placer ground at Atolia, known as the ''spud patch,'' large lumps of nearly pure scheelite were recovered by hand-sorting; they were easily distinguishable by their weight. It has been suggested that hand-sorting could be used today on endless belts under ultra-violet light. This method has two disadvantages. One is that the ores mined today are of such a low grade, and so little gangue is mined, that there is no material which can be discarded that will raise the tenor of the ore, or that can be considered a concentrate. The other disadvantage is the harmful effect of ultra-violet light upon the sorter's eyes and skin.

Gravity-Concentration Methods

As tungsten increased in importance and mining became more prevalent, large-scale operations became necessary. Lower grade ores were mined, and hand-sorting was found to be too slow and expensive. The high specific gravity of the tungsten-bearing minerals immediately suggested gravity concentration. In the earliest deposits worked, quartz and calcite were the two main gangue minerals, each with half the specific gravity of the tungsten minerals. Jigs and vibrating tables were used. A fair recovery and a high-grade concentrate were obtained. It was noticed at this time that the tungsten minerals slimed readily, and all possible attempts were made to cut down the sliming due to crushing. In the arid regions around Atolia, dry concentrating tables were developed and used with satisfactory results.

Grinding and Crushing

Stamps were used at first to break down the ore, but their action resulted in excessive sliming of the tungsten minerals. Rolls were used for the primary crushing, and either secondary rolls or ball mills for the secondary stage. Rolls gave less sliming than ball mills; but it was found that they did not break all the mineral free, as the material could not be broken to a sufficiently fine degree. Sliming was cut to a minimum in ball mills by using mills with a large diameter and short length. An excessive amount of water was used to encourage rapid passage of ore. The product, when ground, was classified, and the oversize returned to the mill.

This has proved to be the most satisfactory grinding method, and is now used almost universally. Jaw crushers or gyratory crushers are used for primary crushing, rolls for secondary, and ball mills for grinding. Rolls are in some cases used for primary crushing, as at Atolia.

Classification

Classification of the ore is important at all stages, to avoid needless crushing and grinding, and thus to prevent excess sliming and excessive costs. The coarse mineral particles should be separated as they are broken free from the matrix. This can be done only by proper classification. The general practice is to separate coarse and fine sands from each other.

Slimes are now being separated and treated by flotation, or stored for treatment when a satisfactory method has been found. The coarse sands are treated in jigs which give a high-grade concentrate, and occupy a minimum amount of floor space. The fine sands are treated on tables and are usually complemented by the reground hutch product from the jigs. Slimes were treated on slime tables, vanners, or canvas tables, but are now almost universally treated by flotation. The adaptability of these concentration processes depends upon the proper use of classifiers and the proper separation of the various products.

Classification is also important in the grinding circuit. The ore is sent through the ball mills with a large ratio of water to minimize the sliming. This means that coarse particles will pass through the mill without being ground, and the various tungsten minerals will not be broken free. The oversize particles must be separated from the pulp and sent back through the mill. This is best done by classifiers in closed circuit with the grinding mills. Both bowl and rake type classifiers are used with apparently satisfactory results.

Jigging

Jigs have been found to be effective on the coarser-size particles. The fixed sieve, or Harz type, jig is used almost entirely. Three products result: concentrate, hutch product, and tailings. The concentrate is usually of a high enough grade to be sacked and shipped without further treatment. The hutch product is reground and treated on tables. The tailings are usually clean enough to be discarded. The Harz-type jig is particularly adapted for this work, as a large amount of ore can be retained on the screen (Vanderburg, W. O. 35a).

Tabling

Various types of vibratory tables have been used in treating the fine sands. Card, Janes, Isbell, Deister, Wilfley, and Overstrom tables all have given good service (Vanderburg, W. O. 35a).

In order to obtain the maximum recovery, it has been found advisable to take a large amount of garnet with the tungsten minerals when it is present, and clean the concentrate at a later stage, with magnetic separators. Tables need a large amount of space, and care must be taken not to overload them, or the recovery will be materially affected. It is advisable to use only one type in any one mill, as standardization results in lower costs. A concentrate, middling product, and tailing product are usually taken. The concentrate is clean enough for sacking and shipping, unless garnet, epidote, and pyrite are present. If these minerals are present, further treatment of the concentrates is necessary. The middling product is treated on following tables, or retreated on the same table. The tailing product used to be discarded, but the tendency now is to treat it by flotation.

Slime Treatment

Monell tables, frue vanners, and stationary canvas tables have all been used in the past for slime treatment. The most favored were the canvas tables, which gave only a 15 to 35 percent WO_3 concentrate. Slimes are today treated entirely by flotation. The recovery, however, is still only fair, and remains a big problem in the tungsten-mining industry. The large plants are all saving their slime tailings, in hopes that some day a method will be devised whereby these slime losses can be recovered.

Dewatering

Grinding with an excess of water, the use of jigs and tables, as well as the use of flotation, necessitate dewatering apparatus. Thickeners are used, and are usually of the Dorr type. In arid regions the dewatering is necessary in order to cut down the loss of water, as the water must be re-used. The pulp can also be handled more easily when dewatered.

Magnetic Separation

The presence of garnet and epidote in the contact-metamorphic deposits necessitated the development of magnetic separation methods. It is difficult to separate the tungsten minerals from garnet and epidote by gravity methods without sacrificing recovery. It was found that garnet and epidote could be saparated by magnetic fields from the tungsten-bearing minerals. A low-grade concentrate could then be taken in order to obtain a high recovery, and an additional treatment step was introduced. Wetherill and Ding (Vanderburg, W.O. 35a) magnetic separators have proved satisfactory. The garnet and epidote, being highly magnetic, are taken off on cross-belts and discarded. In this manner the concentrates, assaying over 60 percent WO_3, are easily made. Pyrite must be roasted before it can be taken out by magnetic separators.

Wolframite and tin ores were treated by magnetic methods. In this practice the mixed concentrates were roasted to expel the sulphur, usually in the form of pyrite. The iron was then taken out by a weak magnetic field, and the wolframite by a stronger one. The wolframite concentrates usually contained tin cemented by iron oxide. This was dissolved by sulphuric acid and the wolframite was then separated by fields of various strengths (Vanderburg, W.O. 35a).

Roasting

Pyrite and various other metallic sulphides are usually found in gravity concentrates. Since the sulphur content of the concentrate must be kept below 0.5 percent maximum, the sulphur must be expelled. Pyrite is not magnetic; but after a short roast, a magnetic film is formed around the pyrite, which can then be separated by magnetic methods. A complete roast is not practical nor is it necessary. The thin film can be formed around a core of unaltered pyrite after a short roast.

There are three important factors in roasting: size of particle, temperature, and length of roast. The larger the particle, the longer the time required for roasting. The temperature must be equal to the ignition temperature of pyrite, and must be maintained sufficiently long for a film to form.

The roasted product is easily tested by its physical appearance. A good roast is characterized by the absence of typical pyrite particles, and by a flat, dead color ranging from bronze to black. In some plants a dead roast follows the treatment by magnetic separators, in order to expel all the remaining sulphur. Roasters can be made at the plant from pipe. At the Nevada-Massachusetts plant a roaster was made from an 8-inch pipe 12 feet long (Heizer, O. F. 30). Roasters are generally oil-fired, and may be either externally or internally heated.

Pneumatolytic Concentration

In the arid regions of southern California and Nevada, the Stebbins dry concentrator found a great deal of use and proved to be satisfactory principally in handling placer ground, though with some success also on lode ore. The pneumatolytic concentrator consists of a hollow metal table with riffles on the surface. Small holes are punched between the riffles, through which air is blown by a fan. The ore is carried over the table on a cushion of air. The recovery is lower on these concentrators than on wet-gravity concentrators, but a 60 percent concentrate can be made. Induced eddy currents make operation of these machines variable, hence adjustment is difficult. Here, again, the great loss is on the fine material. The extremely fine particles are not heavy enough to drop out of the air stream and are carried off (Vanderburg, W. O. 35a). A dry concentrating plant was erected in Nevada, and although test runs on 2 to 4 percent ore proved satisfactory, operation on 1 per cent ore was not profitable (Osborn, W. X. 27).

Centrifugal Concentration

Various attempts have been made to concentrate tungsten slimes by centrifugal methods, but as yet no method has been developed that is successful on a commercial scale. There has been a great deal of work done by H. A. Doerner (29), the results of which are published in Technical Paper 457 of the United States Bureau of Mines.

Assaying of Tungsten Products

The chemical methods of assaying tungsten products are long and expensive; consequently, for mill practice and control, mechanical methods have been developed. At Atolia a specific gravity method has been developed, which is based upon the consistent nature of the quartz-scheelite ore. This method has proven accurate within 2 percent on concentrates.

The equipment consists of a 500-cc flask graduated in 5-cc units and a balance reading in grams capable of holding 200 grams. The sample is ground to 10 mesh. The flask is filled with 400 cc of water, and 200 grams of the sample is poured into the flask. The volume of the water and the solids is read, and the specific gravity is computed as follows:

T = combined value of water and solids in cc

T — 400 = volume of water displaced by 200 grams of concentrates

$$\frac{200}{T - 400} = \text{sp. gr. of concentrates}$$

The WO_3 percentage is then read from a table. This table has been calculated on the assumption that the gangue has the specific gravity of quartz and the ore is scheelite (Vanderburg, W. O. 31). This method is satisfactory only where the ore is uniform, as in the above case.

A method designed to keep the concentrates above 60 percent WO_3 was developed by the Round Valley Tungsten Company. A test sample of 60 percent concentrates was packed tightly in a blasting cap box. The sample to be tested was packed in a similar box. The two were then placed on a balance. If the sample was exactly 60 percent, they balanced; if lower, the test sample rose; if above, the test sample fell. Minor changes in the mill circuit were then made if the sample fell below 60 percent (Vanderburg, W. O. 35a).

Panning is used in most mills, and an experienced mill man can generally estimate percentages to a close degree. Such a method is used for routine mill work. It has been suggested that ultraviolet be used to assay mill products; and it is claimed that an experienced man can get very close results by the use of this method. Ultraviolet lights are now used at the Nevada-Massachusetts plant at Mill City, Nevada for control of mine operations, but not in the mill. For marketing concentrates, an umpire assayer is usually called in and wet chemical methods are used.

Flotation of Tungsten Minerals

The flotation of tungsten minerals has been developed only during the past six years, and the first plant was erected about 1939. Fatty acids or fatty acid soaps such as oleic acid or sodium oleate with an alkaline reagent (for instance, caustic soda, soda ash, or sodium silicate) give a satisfactory separation of scheelite from quartz (Clemmer and O'Meara 34).

The oleic compounds form a film of calcium oleate around the scheelite, and the sodium silicate depresses the quartz (Dean, R. S. 37). Formic acid, hydrochloric, nitric, sulphuric, or sulphurous acid, as well as the short chain organic acids, will depress apatite. Hard water must be softened before flotation can be used, as it consumes reagent and carries gangue over into the concentrate (Dean, R. S. 36). Sodium carbonate plus a little sodium silicate was found to be the most effective combination for softening water, as they do not affect the flotation of scheelite. In cold weather, lime must be added to aid in settling slimes, as they tend to flocculate at low temperatures.

In complex ores the metallic sulphides are usually floated first, as sulphide depressants affect the flotation of scheelite. The sulphides can be floated by any of the common reagents. The scheelite is then floated by adding oleic acid, sodium oleate, and a small quantity of sodium silicate. This rougher froth is then cleaned with sodium silicate reagent which depresses quartz and mica. In the final cleaning, lactic and formic acids are added to depress the remaining mica and apatite. An alkaline circuit is satisfactory if phosphorus (apatite) is absent; but an acid circuit is necessary when it is present.

The following circuit describes the flotation of a contact-metamorphic scheelite ore (Clemmer and O'Meara 34). The sulphides are floated by any of the customary reagents. A relatively large amount of reagent is necessary, and a 10- or 15-minute period is ample. The circuit may be acid or alkaline. The pulp is then conditioned for several minutes with a heavy mineral salt such as copper sulphate. Any salt of a metal which forms a relatively insoluble carbonate may be used—copper nitrate or copper hydroxide are equally effective. This may be added during the sulphide conditioning, as it has no effect upon the sulphide flotation. A minimum conditioning period gives a high-grade concentrate, low in phosphorus, and a fair recovery. A longer period of 5 to 10 minutes gives an increased recovery and a lower grade concentrate, as the apatite is not rejected as thoroughly with the short period. In the rougher circuit a soluble silicate is used with oleic acid and sodium oleate to float the scheelite. Calcite and apatite are retarded by the metal-salt—silicate combination. The amount of reagent used depends upon the ore, and varies considerable.

In the cleaner circuit, the rougher froth is cleaned once or twice with silicate or an acid constituent, to depress the residual calcite and apatite. It is easier to follow this process than to depress the scheelite and float the apatite and calcite. Apatite and calcite can be removed by leaching, as the scheelite is not affected by acid. Acid consumption depends upon the gangue; if siliceous, the consumption is low. At Atolia the concentrates are leached with hydrochloric acid, to take out the calcite and apatite. Leaching allows for a higher recovery of scheelite and for simpler flotation procedure.

Hübnerite, wolframite, and ferberite are all subject to flotation, but not so readily as scheelite (Clemmer and O'Meara 34). Oleic acid and sodium oleate are used as activators; and soda ash, caustic soda, and silicate are used to depress the silica. An acid cleaning is necessary to cut down the phosphorus content of the ore. In some ores an acid depresses ferberite, but a metal salt renders ferberite less sensitive to acid depression. Manganese sulphate worked very satisfactorily in such an instance. Here, as with scheelite, a metal-salt-acid combination effectively depresses apatite.

Wolframite and scheelite can be separated from each other by flotation. This is not necessary unless another element which can not be depressed, such as fluorite, is present. Wolframite would be separated from a scheelite-fluorite product. The scheelite could then be separated from the fluorite. The reagents mentioned above are used in such cases (Clemmer and O'Meara 34).

The above information is drawn primarily from tests run by the United States Bureau of Mines, the results of which are published in the Reports of Investigations referred to in the Bibliography. The flotation of tungsten ores is still in an early stage of development, and only a few mills have flotation plants. The operation of these plants has not been altogether satisfactory, and experimentation is still being carried on simultaneously with operation. Changes in flow-sheets are continually being made, and it is therefore difficult to present many examples of practice.

Examples of Practice

The following three plants have been largely augmented by flotation practice. However, flotation is used in conjunction with gravity processes rather than in place of them.

Atolia Placer Plant (Vanderburg, W. O. 31)

At the Atolia placer plant, an average of 405 tons of ore were treated per day, at a cost of $0.37 per ton. The tailings assayed 1.5 percent WO_3, mostly as slimes; but some of the WO_3 was locked with quartz. Jigs of the Harz type were used on the coarse material, and the fines were treated on Overstrom concentrating tables. Magnetic separation was used to clean the concentrate of magnetite. A 70 percent recovery was made, and 62 percent concentrates were obtained. The plant is now idle, as it could not operate profitably. It is believed that the mill was overloaded and could be operated profitably if a smaller tonnage were handled, and if some of the gold which is present were recovered.

There are several known channels which lead to known ore-bearing lode regions near the Union shaft of the Atolia Mining Company. The old tailings from this plant are now being treated in the Atolia flotation plant with success.

Union Mine Ore Plant (Vanderburg, W. O. 31)

The ore was hand-treated on an endless belt. The waste rejected here comprised about 25 percent of the dump material. The ore was crushed in a 10 by 16 Blake-type crusher, equipped with corrugated manganese steel wearing plates. The material was then screened on a $\frac{1}{4}$-inch opening vibratory screen. The oversize was crushed in a 3-foot Symons cone crusher, set to $\frac{1}{4}$ inch. The crushed product was then classified by a stationary inclined screen 2 feet wide by 5 feet long, with .0425-inch openings. The oversize was treated in a Traylor two-compartment fixed-sieve jig. The concentrates were removed by hand skimming. The tailings were dewatered and led to the dump, and the hutch product went to the concentrating tables. The undersize was treated on two Overstrom single-deck tables. The middlings were re-treated on the tables; the tailings dewatered by dewatering drag classifiers and discarded; the concentrates dried and treated by magnetic separators. The table concentrates were dried and fed to a Wetherill magnetic separator for the removal of magnetite. The concentrate was then roasted in an eight-hearth oil-fired Herreshoff furnace 3 feet in diameter and 6 feet high. The pyrite was changed to a magnetic sulphide, and the apatite decrepitated so that the phosphorus went off in the furnace dust. The roasted concentrates were then re-treated by the magnetic separator, to dispose of the last of the sulphur. These concentrates were mixed with the jig concentrates, sacked, and shipped.

An analysis of the ore shipped is as follows:

	Percent
WO_3	66.58
Sulphur	0.16
Phosphorus	0.034
Arsenic tin	0.007
Tin	none
Copper	none

The estimated recovery was about 80 percent, with approximately 1 pound of scheelite in each ton of tailings. This plant is now idle. The ore mined is now treated by gravity and flotation in a new mill, which will be described later.

Atolia Flotation Plant

The Atolia Mining Company has a new gravity-flotation plant which was first put into operation in 1939. The flotation plant is re-treating old Union and Papoose mill tails, together with all tailings produced by the gravity section of the mill.

Recovery varies with the head value and the percentage of colloidal slime present. Average recovery is approximately 85 percent.

The amounts of reagents used are variable, depending upon the material treated. A close check is kept on the tails, to keep them below 0.1 percent WO_3. When they rise above this value, reagents are added until they fall below again.

The tailings are ground in a ball mill in a very dilute pulp, to minimize sliming of the scheelite. The mill product is classified, and the sands are sent to the dump. The slimes are divided and sent to the flotation circuit. Two-thirds of the slimes go to nine cells, which were designed and constructed at the mill. The pulp passes through all nine cells, and then goes off to the tailings pond. The froth is taken to four Kraut cleaner cells. The tailing from the cleaners is re-treated in the rougher section, and the froth goes to a thickener. The remaining third goes to two Atolia cells and then to twelve Kraut rougher cells. The tailing from these is taken to the tailing pond. The froth is taken to four Kraut cleaner cells. The tails from these are re-treated in the rougher section, and the froth goes to the thickener.[5]

After the concentrates are thickened, they are sent to the leaching plant. In the leaching plant the concentrates are pumped into large, deep tanks equipped with agitating rakes. From 3 to 4 tons of 1 percent hydrochloric acid solution are added to each tank. The pulp is then agitated for 1½ hours. It is then allowed to settle until clear, usually requiring 2½ hours. The solution is decanted. The first water wash is added, the pulp agitated for 1½ hours, allowed to settle for 2½ hours, and the water decanted. There are two more water washes which follow the same procedure. The pulp is then sent to a thickener and from there pumped to a dryer. The dry concentrate is sacked and shipped. Reagents are added just before the pulp reaches the cells, and also when it is in the cells. Reagents may also be added as the pulp enters the ball mill, but that results in a large loss, as the sand is rejected immediately to the tailings pond and carries a large portion of the reagent away.

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[5] Since the above was written, the flotation circuit has been rebuilt, Kraut and Atolia cells cut out and replaced by Fagergren and Pan-American machines. Pan-American agitators replaced locally designed agitators in the large sand tanks. Sands are now ground for contained value and go to flotation.

One operator per shift can handle the plant. The various products are sampled and panned at regular intervals by the operator. Routine head and tailing samples are also taken,but these are assayed by more exact methods.

The tailing loss is still too high, but the scheelite is so very fine that it can not be recovered by any known methods. The Nevada-Massachusetts Company is experiencing this same trouble with slime scheelite on their contact-metamorphic ore, and are experimenting to find a way to treat it. Thus far they have not been successful. It seems advisable to retain a careful check on the tailings, and to save them until a time when these slimes can be treated and the contained scheelite recovered.

PRODUCTION OF TUNGSTEN IN CALIFORNIA

Although the production of tungsten in California is but a small proportion of the world production, it is a large and important part of the total production of the United States. The first commercial production of tungsten ores and concentrates was in 1905. At that time the ferberite deposits of Colorado were the chief producers in this country. In 1906 the mines at Atolia were first developed and exploited. In 1915 California forged ahead of Colorado as the leading producer of tungsten concentrates in the Uinted States. During the boom years of the World War, California and Colorado dominated the United States in production. From 1920 to 1922 there was no production from California.

With the passage of the Tariff Act of 1922, which placed a duty of 45 cents per pound of tungsten content on all imports, the tungsten industry was revived and California led this country in production. California dominated the field until 1927, when Nevada became the leading producer. Although the production of tungsten in California has steadily increased since then, Nevada has remained first in the domestic production of tungsten ores and concentrates in the United States.

The history of tungsten production has followed the eras of prosperity and depression of the United States; but it has furthermore been affected by three other factors, namely, tariff, war, and war scares. Without a tariff the tungsten industry would be nil in this country, as it was from 1920 to 1923.

Also, in time of war the steel industry is stimulated, causing a greater demand for tungsten in the form of tool steel. Revival of interest in the tungsten industry follows the passage of new tariff rates and the demand made by armament programs.

Period from 1905 to 1914

In the period from 1905 to 1914, the production of tungsten from California was small. It increased gradually through this period, with minor fluctuations. The maximum production was reached in 1909, when 524 short tons of concentrates containing 60 percent WO_3 were shipped. In 1913, 506 short tons were produced, and in 1914 the production fell off sharply to 381 short tons. Almost the entire production came from two districts in San Bernardino County and Kern County. The first tungsten mining was done in the Stringer district in eastern Kern County, south of Randsburg. This district had been worked for years for its gold ores. Minor amounts of scheelite occurred in the veins, and 52 short tons of concentrates were produced. In 1906 the adjacent deposits at Atolia were discovered and developed. Production jumped to 440 short tons, and the long period of mining at Atolia started. Atolia has continued to be the largest producer in California until recent years.

Period from 1914 to 1919

With the outbreak of the war in Europe in 1914, the tungsten industry experienced a great boom. Prices rose to over $90 per unit, and production increased five-fold. New deposits were discovered and opened, mills were built, and production came from even the small deposits throughout the southern part of the State. The peak was reached in 1917, when 2,466 short tons were produced. This peak of 1917 was brought about in part by the organization of the War Minerals Commission in July of that year. This commission was appointed by the President of the United States, to stimulate mining and production of necessary war minerals, and to encourage the working of small deposits in order to insure an adequate supply of these minerals to carry on the war in Europe successfully. It was felt that risk had to be taken in order that money would be invested and small deposits, which ordinarily would be idle, might be worked.

This bill was modeled after the Food Control Act, and gave the Government virtual control over strategic mineral mining. The Government reserved the right to operate mines and to settle litigation so that mines, which had been held idle because of controversy, could be operated (Westervelt, W. Y. 18). Prices were held at a high level, an adequate market was assured, and speculation was held in check as much as possible.

Atolia at this time was still the main producing district, but a new district was developed during the same period which followed Atolia closely in importance—the Bishop district.

Although the presence of tungsten minerals in the Bishop district had been known since 1913, it was not until early in 1916 that The Tungsten Mines Company and The Standard Tungsten Company acquired claims and rushed to completion the construction of mills for treating the ore (Hess and Larsen 22). The Pine Creek Tungsten Company completed their mill late in 1918, and the Round Valley Tungsten Company started mining operations at about the same time. Small production came from the New York and Clark Mountain districts, in eastern San Bernardino County. There was also some production from small deposits in the Greenhorn district near Kernville, Kern County. The Ubehebe district was discovered in 1916, but only a few tons were shipped from there. Other deposits discovered at this time, which gave only a small production, were the Deep Springs Valley deposits, the deposits near Benton, and those near Victorville in southern San Bernardino County. With the close of the war, prices fell and production slumped. In 1919, only 214 short tons of tungsten concentrates were produced in California.

Period from 1919 to 1929

At the close of the war there was no longer a need to stimulate the mining of war minerals, and the Government withdrew its support and restrictions. As a consequence, numerous properties were closed—having been opened at the encouragement of the Government—and heavy losses were sustained by the owners.

In order "to provide relief in cases of contracts connected with the prosecution of the war, and for other purposes under given conditions"[6] and to help relieve the burden of these losses, the Secretary of the Interior was authorized to investigate and adjust claims on net losses sustained in the production, or attempted production, of the necessary war minerals during the war period as a result of Government stimulation (Bain, H. F. 21). A commission of three men, known as the War Minerals Relief Commission, was appointed by the Secretary of the Interior to investigate and review the claims filed. Several amendments have been made to the original Act, establishing this commission.

The first of these amendments restricted the war minerals to pyrite, manganese, chrome, and tungsten. The next important amendment came in 1929, after several bitter conflicts over claims and years of discussion in Congress. This amendment allowed the decisions of the Secretary of the Interior, which had heretofore been heard by the commission and accepted by the Secretary, to be heard by courts. The majority of the claims were passed on without difficulty or dissention, but some decisions of the commission were bitterly contested and were carried as far as the Supreme Court.

The case of the Chestatee Pyrites and Chemical Corporation is a very good example. The claim was brought in 1919 for interest on money borrowed for production and preparation of pyrites during the war. In August of 1919 the commission awarded $219,607.90, but the Corporation demanded the full amount of the claim, $914,172.73. The case was awarded to the Corporation by lower courts and, in 1929, Secretary Wilbur asked and received permission to have the case heard in the Supreme Court (Engineering and Mining Journal 31). A study of the work and decisions of the War Minerals Relief Commission and the War Minerals Commission is interesting and the subjects important in themselves. A study of this kind would be of value, to point out the difficulties which were experienced, so that they may be avoided in the future.

The authorization of these repayments on claims by the Government, coupled with the low prices which were being asked in New

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[6] Section 5 of the Act of March 2, 1919 (40 Stat., 1272-1274).

York, stopped the production of tungsten in California from 1920 to 1923. In 1921 the price fell to $1.50 per unit.

The Tariff Act of 1922 was passed and a levy of 45 cents per pound of contained tungsten was placed on all ores imported into the United States. This amounted to $7.14 per unit. With such protection, prices rose and production started again throughout this country. In 1923, California reported a production of 34 short tons. Production rose rapidly in 1924 to 781 short tons, then fell off gradually until in 1929 only 150 tons were produced. The inflation period of 1924 to 1929 did not affect the tungsten industry as it did other industries.

Period from 1929 to 1938

Production continued to decline in California until 1932, when only 26 short tons were produced. This, in spite of a rise in the tariff duty to 50 cents per pound of contained tungsten. The sharp increase in this country's production that occurred in 1931 was a result of the rise in duty. It did not last, however, and the effect was not felt in California. Production in the United States in 1930 was 637 tons; in 1931 it increased to 1,274 tons; fell to 359 tons in 1932. The effect of the depression on the tungsten industry was shown by this slump. Beginning in 1933, the tungsten production of California has increased steadily, except for a minor slump in 1935. In 1938 the production was 732 tons—the highest since 1924, when 781 tons were produced. The production of tungsten in the rest of the United States increased even faster than in California, due primarily to the growth of the Nevada-Massachusetts Mining Company at Mill City, Nevada.

In 1937, with the advent of a heavy rearmament program, prices rose suddenly from a maximum of $16 per unit in 1936 to a maximum of $35 in 1937.

Prices then dropped to a maximum of $24 in 1938 and 1939. The production did not, however, respond as actively to this price change as it did in 1915 and 1916, but continued to rise gradually. The total production in the United States in 1937 was at its highest point since 1918, with a total yield of 3,500 tons. In 1938 the domestic production dropped slightly, to 3,044 tons. California has, since the World War, been displaced as the principal producer in this country, being succeeded by Nevada. In 1917 California produced 44 percent of the tungsten produced in the United States. In 1938 it produced only 24 percent.

With the rise in interest stimulated by the present war in Europe, it is expected that California will rise in importance as a producer in the United States. As a consequence, the production figures for 1939 were nearly double those for 1938.

Total Tungsten Ore Production of California[7]

The annual amount and value of tungsten ores and concentrates produced in California since the inception of the industry is given herewith, with tonnages recalculated to 60% WO_3:

Year	Tons at 60% WO_3	Value
1905	57	$18,800
1906	485	189,100
1907	287	120,587
1908	105	37,750
1909	577	190,500
1910	457	208,245
1911	387	127,706
1912	572	206,000
1913	559	234,673
1914	420	180,575
1915	962	1,005,467
1916	2,270	4,571,521
1917	2,466	3,079,013
1918	1,982	2,832,222
1919	214	219,316
1920	----------	----------
1923	34	19,126
1924	781	$446,009
1925	573	348,475
1926	441	316,560
1927 1928 [a]	389	429,237
1929	150	106,280
1930 1931 [a]	120	82,582
1932	26	9,509
1933	148	76,605
1934	261	224,417
1935	118	194,542
1936	236	210,819
1937	611	782,187
1938	732	786,860
1939	1,235	1,152,735
Totals	17,664	$18,407,314

[a] Annual details concealed under 'Unapportioned.'

CALIFORNIA TUNGSTEN DEPOSITS

The purpose of the following discussion is to review the tungsten resources of California. A brief description is given of the producing mines, past producing mines, and promising prospects. There are hundreds of claims located throughout the State which are not discussed here, but which will appear on a State map, now in preparation under the direction of Olaf P. Jenkins, Chief Geologist of the California State Division of Mines. This map will show tungsten properties, claims and prospects, as well as mines, and should be used by the reader to get a clearer idea of the distribution of tungsten in California.

Tungsten is found throughout the central and southern parts of the State. The two main districts are at Atolia, San Bernardino County, and at Bishop, Inyo County. Other important areas are near Kernville, Kern County; in eastern San Bernardino County near Goffs and Ivanpah; in Tulare County near Posey (Jack Ranch). A large number of claims have been located in eastern Fresno County near Trimmer, but no producing mines have been developed there. Other deposits are in eastern Inyo, Nevada, Placer, Santa Cruz, Monterey, Madera, Riverside, and San Diego Counties.

These tungsten occurrences can be separated both geographically and geologically into three provinces: (1) Sierras, (2) Atolia, and (3) eastern San Bernardino County.

The deposits of the Sierras are closely connected with the great Sierra batholith, and are of the epithermal and mesothermal vein type, or of the contact-metamorphic type. The deposits at Atolia are of the epithermal quartz-scheelite vein type. The deposits of eastern San Bernardino County are of the hypothermal and pegmatitic vein type, and are the oldest deposits. Other deposits fall outside of these provinces; they are small in number and size, and are unimportant.

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[7] Table reproduced from Bulletin 119 (Symons, H. H. 40).

The references given in the following descriptions are for the most part publications of the California State Division of Mines. The bulletins referred to are of several types. Most of them are California mineral production bulletins, and some are geologic reports prepared on certain important districts. The field reports are confidential reports prepared by the field men of the Division, and are on file at the offices in San Francisco. Other references are the Bulletins and Professional Papers of the United States Geological Survey, Mineral Resources, Mineral Industry, and the Engineering and Mining Journal. Footnotes have been deleted for the sake of simplicity; the material is taken from the references given at the end of each description or from personal experience and communication.

Atolia District

This is the most important tungsten-producing district in the State. The mines of the Atolia Mining Company were for years the largest single scheelite producers in the world. The area was first developed for its gold ores in the late 1890's. In 1905 scheelite was discovered, and in 1906 the Atolia mines were first developed. The district encloses the area around the towns of Randsburg, Johannesburg, Red Mountain, and Atolia. It lies on the eastern and northern slopes of a low range of hills known as the Rand Mountains. The country is arid. Water is scarce, and much that is used is hauled in. There is no railroad to the district, but good roads connect with the Southern Pacific line 6 miles to the north, and the Santa Fe line 30 miles to the south. In summer the weather is very hot, and in winter extremely cold.

The district is honeycombed with mines, shafts, and prospects. The three main mines of the district are the Yellow Aster (gold) at Randsburg, the California Rand silver mine at Red Mountain, and the Atolia mine (tungsten) at Atolia. The mines at Atolia have been producing tungsten steadily since 1906, except for a brief period from 1920 to 1922. It has been estimated that about half the ore originally present in this group of mines has been mined. The mines in this group have been worked by lessees in a rather haphazard fashion, and it is believed that a systematic prospecting program would uncover new ore-shoots.

Scheelite occurs in other parts of the district, in narrow stringers which can be mined during periods of high prices for their tungsten ores. At present lessees are fairly active, and only one mill is operating on tungsten ores.

A systematic prospecting program will have to be carried out, to discover new ore-shoots, before any large mining operations can be expected. Lessees can be expected to do little or no prospecting and, once ore is out of sight, their operations are usually curtailed. The easily found ore-shoots have all been mined out; it remains to find the hidden ore-shoots. In working the older mines it was found that the ore-shoots often do not carry to the surface. Diamond drilling might be used to advantage in discovering new parallel veins and shoots. Ore may also be expected at depth. A price of more than $10 per unit is needed for working these deposits. Better milling methods would tend to stimulate tungsten mining in this district.

This district will continue to be a factor in the production of tungsten in California for several years to come.

American Gold and Tungsten Corporation

Location. Sec. 19, T. 30 S., R. 40 E., M. D. This group of four unpatented lode claims lies north of the Union mine of the Atolia Company at the west end of the district.

Owner. American Gold and Tungsten Corporation.

Production History. The Top Notch claim has produced a small tonnage. It is not producing at the present time.

Mine and Plant. The property is opened by a shaft 165 feet deep, which follows the vein on an incline of 38° to the north. A small amount of scheelite was produced from the upper workings, but the lower levels were barren. The vein shows signs of carbonatization, and the walls are sericitized and pyritized. A vein 150 feet to the north contains more scheelite, but has been developed only by a shallow shaft. Several other shafts are sunk on another vein which strikes N. 32° W., and dips 40° to 60° NE.

Bibliography. Lemmon and Dorr 40, p. 244.

Atolia Mining Company

Location. Secs. 19, 20, and 21, T. 30 S., R. 41 E., M. D. The holdings cover a zone two miles in length, extending east and west just south of the town of Atolia. The company owns the following mines: Acaley, Amity, Atilia, Churchill, Flat Iron, Goldstone, Mahood, Par, Papoose, Potato Patch, Rainstorm, Spanish, Paradox No. 1, Paradox No. 3, and Union. Total: 60 patented claims, approximately 1200 acres.

Owner. Atolia Mining Company; L. Wernecke, president; H. W. Coke, superintendent; main office, 1022 Crocker Building, San Francisco; mine office, Atolia.

Production History. This property was first located and developed in 1906. Production started immediately, and continued without interruption until 1919. During this first 13-year period 514,382 units of WO_3 were produced. This was contained in high-grade scheelite ore, and in scheelite concentrates assaying approximately 70 percent WO_3. Production was resumed in 1924 and continued until 1926. In 1930 production was again reported, but in the following two years no production was made. In 1933 production was resumed, and the property was still producing in 1940. The property was, until 1934, the leading tungsten producer in the United States, and was considered the largest scheelite deposit in the world. Little work is being done on the property now. A few lessees are working and the mill is re-treating old tailings. Several mines are being reopened and active development is under way in the Union, Amity and Paradox No. 3.

General Geology. The ore is scheelite which occurs in quartz fissure veins in granite. The veins are in a belt about 2 miles long and 1 mile wide. They are short and often branch. The ore-shoots are triangular in shape, with the apex downward. Active faulting took place during the ore deposition as well as after the ore formation. The detailed geology is given in the chapter on geology.

Mine and Plant. The deposits are worked through numerous mines and shafts. The more important shafts are listed above. The Union mine was the largest producer, and was worked to a depth of 1,000 feet. The ore was mined by shrinkage methods. A new mill was completed in 1939, and is described in the chapter on ore dressing.

Bibliography. Boalich and Castello 18, p. 12; California State Division of Mines 13, no. 3; no. 201; Cloudman, Merrill, and Huguenin 19, p. 835; Fink, C. G. 15, p. 747; 16, pp. 687-689; 17, p. 724; 18, p. 700; 24, p. 684; 26, p. 701; 28, p. 593; 29, p. 609; 31, p. 614; 32, p. 557; 34, p. 572; 35, p. 572; 36, p. 587; 37, p. 601; Hess, F. L. 17a, p. 824; 19, p. 791; 21, p. 939; 21a, p. 979; 29, p. 261; 29a, p. 123; 33, p. 182; 35, p. 494; Hulin, C. D. 25, pp. 71, 125; Lemmon and Dorr 40; Lund, R. J. 37, p. 657; Ridgway and Davis 38, p. 569; Symons, H. H. 29, p. 193; 30, p. 210; 31, p. 209; 32, p. 206; 34, p. 187; 35, p. 306; 36, p. 178; 37, p. 172; 38, p. 173; Tucker, W. B. 21, p. 370; 24, p. 96; Tucker and Sampson 30, p. 291; 31, p. 365.

Atolia-Rand Placers, Inc. (Formerly Nieto Placer Group)

Location. Secs. 19 and 30, T. 30 S., R. 41 E., M.D. The Redondo Pete claim, the only lode claim developed and patented by their company, lies in the center of the Atolia Company's holdings adjacent to the Rainstorm claim. Atolia-Rand Placers, however, owns a large placer acreage to the south of the Union mine of the Atolia Company.

Owner. Formerly, John Nieto, Seaside Terrace, Santa Monica. The present owner is Atolia-Rand Placers, Inc., a subsidiary of the Molybdenum Corporation of America.

Production History. There was production from the group of placer claims from 1915 to 1919. The Redondo Pete property was developed in 1917 under lease to the Blackhawk Mining Company, and was abandoned in 1919 after a small production. The War Minerals Relief Commission paid a large claim for the development. The placer property was operated again in 1935 and 1936. There is no record of the amount produced, however. New machinery is now being installed for work on the placer ground.

General Geology. The placer deposit is of the ''spud'' type. ''Spuds'' were found throughout the 15 to 18 feet of bedrock. The best streak, however, consisted of material resting on the bedrock in depressions. The streaks varied from 6 to 24 inches in thickness. Two ledges cross the property, and shafts were sunk on them to a depth of 100 feet, but no ore was encountered.

Mine and Plant. The shaft of the Redondo Pete was sunk vertically to a depth of 500 feet. Levels were run at the 300 and 500-foot levels. Ore was found on the 500 level in two veins south of the shaft. A small tonnage was stoped from the south vein and several raises were run by the owners on this vein.

Bibliography. California State Division of Mines 13, no. 318; no. 327; Fink, C. G. 35, p. 572; 37, p. 601; Lemmon and Dorr 40; Symons, H. H. 36, p. 178; 37, p. 172; Tucker and Sampson 30, p. 294.

Black Hawk Tungsten Mine

Location. Secs. 19, 29, 30, 7, T. 30 S., R. 41 E., and Sec. 12, T. 30 S., R. 40 E., M.D. This mine is comprised of 5 claims formerly known as the Leonard and Halloran group. It is located 1 mile west of the town of Atolia.

Owner. Black Hawk Tungsten Mines Corporation; M. L. Conroy, president; offices, 527 Front Street, San Pedro, California.

Production History. Production was reported in 1906, 1914-18, and 1920. More than $200,000 in gold has been taken out. The tungsten production has been small. The mine is now idle.

General Geology. The ore is in the form of scheelite in quartz veins. The country rock is schist. The vein carried $6 per ton in gold (old price) and a small amount of tungsten.

Mine and Plant. The mine is opened by four shafts from 70 to 130 feet deep, and 4,000 feet of drift. The mine equipment consisted of two horse-whims, blacksmith shop, and cabins. The reduction equipment consisted of a five-stamp mill.

Bibliography. Boalich and Castello 18, p. 12; Brown, G. C. 16, pp. 489, 522; California State Division of Mines 13, no. 27; no. 184; Tucker, W. B. 21, p. 372; Tucker and Sampson 30, p. 293; 31, p. 366.

Buckeye Tungsten Mine

Location. Sec. 18, T. 30 S., R. 41 E., M.D. This mine is 1½ miles west by north of Atolia.

Owner. Buckeye Tungsten Company; C. C. Ray, president; W. M. Keeling, secretary, Atolia.

Production History. The mine was a small tungsten producer in 1918. It is now idle.

General Geology. Three parallel veins cut the granite country rock, striking N. 80° W. and dipping to the north. The three veins are about 50 feet apart, and vary in width from 2 inches to 2 feet. The gangue is calcite and quartz. Scheelite is the ore mineral, and is disseminated throughout the quartz.

Mine and Plant. The middle vein is opened by trenches and cuts at 300-foot intervals along its strike. Two 50-foot shafts have been sunk on the vein.

Bibliography. California State Division of Mines 13, no. 200; Tucker, W. B. 21, p. 373; Tucker and Sampson 31, p. 294.

Capitola Mine

Location. Sec. 11, T. 30 S., R. 40 E., M.D. The mine comprises several claims located in the Atolia district, about 2 miles south of Randsburg.

Owner. (1929) Capitola Mining Company, Los Angeles.

Production. A small production was reported in 1929. A 150-foot shaft was sunk and a 20-ton concentration mill was built. The property is now idle.

Bibliography. Tucker, W. B. 29, p. 62.

Federal Company's Group

Location. Secs. 19 and 20, T. 30 S., R. 41 E., M.D. This group includes 14 unpatented lode claims south of the holdings of the Atolia Company.

Owners. J. C. Raynor, N. H. Meyers, and G. T. Ingram, of Atolia.

Production History. Production is reported up to 1930 and is said to amount to $30,000. In 1930 one man was employed on assessment work.

Mine and Plant. On the Federal claim two shafts have been sunk to depths of 240 and 50 feet on the incline. On the 240-foot level, there are 160 feet of drift. On the Wedge Fraction, Monitor, and Ready Cash claims, several more shafts of a maximum depth of 60 feet have been sunk. Several ore shoots are cut off at a depth of 40 feet by faults, and no ore reserves are apparent. Cross-cutting might pick up the extension of the near-surface orebody.

Bibliography. Lemmon and Dorr 40, pp. 240-241; Tucker and Sampson 31, p. 294.

Gold Crown Consolidated

Location. Secs. 11 and 12, T. 30 S., R. 40 E., M.D. The mine, formerly known as the Gold King group, is located about 2½ miles south of Johannesburg.

Owner. (1916) H. W. Mauby of Randsburg.

Production History. This property was a small gold producer, bringing $1500 in gold from several veins in schist. Although no tungsten was reported as having been produced from the mine, tungsten in the form of scheelite does occur in the vein. The property is now idle.

Bibliography. Boalich and Castello 18, p. 13; Brown, G. C. 16, p. 522; California State Division of Mines 13, no. 5.

Gustave Group

Location. Sec. 20, T. 30 S., R. 41 E., M.D. Just south of the town of Atolia, some coarse float was found, and the Gustave group of claims was located.

Owner. Not known.

Production History. Trenching on the deposit resulted in the uncovering of some small scheelite-bearing veins. Some production was reported in 1916.

Bibliography. Cloudman, Merrill, and Huguenin 19, p. 837; Tucker and Sampson 30, p. 294.

Gypsy Group

Location. Sec. 20, T. 30 S., R. 41 E., M.D. This group of 5 claims is located near the town of Atolia.

Owner. (1917) A. Nixon of Randsburg.

Production History. Some high-grade scheelite ore was mined in 1917, but no production has been reported since that date.

Bibliography. Boalich and Castello 18, p. 13; Cloudman, Merrill, and Huguenin 19, p. 839; Engineering and Mining Journal 17, p. 1144; Fink, C. G. 18, p. 701.

Jersey Lily Group

Location. Sec. 7, T. 30 S., R. 41 E., M.D. The group is located north of the Black Hawk mine in the Atolia district.

Owner. (1918) Rare Metals Refining Company.

Production History. Production from this group of claims was reported in 1917 and 1918, but the amount produced was not disclosed. Scheelite was the ore mineral.

Bibliography. Hess, F. L. 21a, p. 981; Hulin, C. D. 25, pp. 72, 144.

W. H. Mann Property

Location. T. 30 S., R. 41 E., M.D. Near Atolia, San Bernardino County.

Owner. W. H. Mann, Randsburg.

Production History. A small production of tungsten was reported in 1929.

Bibliography. Symons, H. H. 30, p. 210.

Monarch Tungsten Gold Mining Company

Location. Sec. 1, T. 30 S., R. 40 E., M.D. This deposit is located in the Atolia district, Kern County.

Owner. Monarch Rand Mining Company; W. O. Walker, president, Los Angeles, California; W. A. Wise, secretary, 6616 Passaic Street, Huntington Park. Under lease and bond to Monarch Tungsten Gold Mining Company, Arthur N. King and Associates, Vancouver, Washington. Mine address, Randsburg, California.

Production History. The mine was primarily a gold producer with some scheelite production. It was slightly developed with shallow shafts. Ore was not found in place, but as gold and tungsten float. The property is now idle.

Bibliography. Brown, G. C. 16, pp. 505, 522.

Osdick Group

Location. Secs. 20 and 21, T. 30 S., R. 41 E., M.D. This group of seven claims adjoins the Atolia Company on the east. Several shafts opened two veins which continue over from the Atolia Company's property. The Skylark shaft, 167 feet deep, is on an eastern extension of the Flatiron system; the Big Ben, 185 feet deep, is on the Spanish vein of the Atolia system.

Owner. P. J. Osdick of Atolia.

Production History. This was the most important single producer of scheelite in the Atolia district, outside of the Atolia Mining Company's mines. No figures are available for the total production, although Mr. Osdick reports a return of nearly $250,000 from the Skylark mine. The property is now idle.

General Geology. The ore mineral is scheelite. The ore occurs in two veins in granite, and is often of very high grade. One pocket yielded, in March 1916, twenty-four tons of vein scheelite which sold for $45,000. The mine was developed down to the 100-foot level and ore was present at depth. There is little remaining ore, and that which is in sight is of low grade.

Bibliography. Boalich and Castello 18, p. 13; Cloudman, Merrill, and Huguenin 19, p. 837; Fink, C. G. 16, p. 687; Hess, F. L. 17a, p. 824; Lemmon and Dorr 40, pp. 240-241; Martin, A. H. 16, p. 295; Tucker and Sampson 30, p. 295.

Placer Gold Company

Location. Sec. 1, T. 30 S., R. 40 E., M.D. This group of claims is located in the Atolia district, about half a mile south of Johannesburg.

Owner. Placer Gold Company, Los Angeles; president, E. Dunham; superintendent, H. R. Wynn.

Production History. This ground was worked from 1898 to 1914 by dry-wash methods. Gold was the main product. Some tungsten was produced in the later years. The property is now idle.

Bibliography. Boalich and Castello 18, p. 13; Brown, G. C. 16, p. 507; California State Division of Mines 13, no. 4.

Quirk Claims

Location. Sec. 17, T. 30 S., R. 41 E., M.D. This group of claims is located a mile north of Atolia, San Bernardino County.

Owner. (1916) Mr. Quirk, Atolia.

Production History. A small tonnage of high-grade ore was mined during the World War; there has been no production since.

General Geology. The ore was massive scheelite in a 4-inch quartz vein running parallel to the main Atolia system.

Bibliography. Boalich and Castello 18, p. 14; Cloudman, Merrill, and Huguenin 19, p. 839.

Rose Fraction

Location. The property is located at Atolia, San Bernardino County.

Owners. (1916) R. Scott and F. Weise.

Production History. A small production was reported in 1916. The property is now idle.

Bibliography. Boalich and Castello 18, p. 14; Cloudman, Merrill, and Huguenin 19, p. 839.

Royal Bohee Group (Royal Bohn)

Location. Sec. 9, T. 30 S., R. 40 E., M.D. This prospect is situated about 5 miles southwest of Randsburg, in the Atolia district.

Owner. A. M. Powell of Randsburg.

Production History. In 1910 this mine was a gold producer; 17 tons of tungsten were produced in 1914.

General Geology. The ore consists of scheelite in stringers of quartz varying in width from less than 1 inch to 6 inches. The country rock is a green amphibolite schist. Stringers occur in a zone half a mile in length. There are two systems of fissuring; the main one strikes N. 50 E., and the minor system branches off from the main one and strikes east.

Mine and Plant. The main working is an adit driven 240 feet along a branch fissure 4 inches wide that assays from 4 to 6 percent WO_3. There are several other adits and drifts on other stringers.

Bibliography. Boalich and Castello 18, p. 13; Brown, G. C. 16, pp. 509, 522; California State Division of Mines 13, no. 11; Tucker, W. B. 21, p. 316; 29, p. 63.

Santa Ana Gold Mines

Location. Sec. 11, T. 30 S., R. 40 E., M.D. This tungsten prospect is located 2½ miles southwest of Randsburg, in the Atolia district.

Owner. Santa Ana Gold Mines Company, Los Angeles; president, F. Layton; secretary, J. Montgomery.

Production History. A production of $400,000 is claimed, entirely in gold. It is only a tungsten prospect, and has had no tungsten production. It is now idle.

General Geology. The deposit consists of a small quartz vein carrying gold and scheelite in schist.

Bibliography. Boalich and Castello 18, p. 13; California State Division of Mines 13, no. 6; Brown, G. C. 16, pp. 509, 522.

Scheelite Group

Location. Sec. 21, T. 30 S., R. 41 E., M.D. This group of claims is located in the Atolia district.

Owner. (1916) Mr. Hart, Los Angeles.

Production History. A small production was reported in 1915.

Bibliography. Cloudman, Merrill, and Huguenin 19, p. 839; Fink, C. G. 16, p. 687; Martin, A. H. 16, p. 295.

Sunshine Prospect

Location. Sec. 11, T. 30 S., R. 40 E., M.D. This prospect is in the Atolia district, about 2½ miles southwest of Johannesburg, Kern County.

Owner. (1915) T. W. Atkinson, Randsburg.

Production History. This mine was a gold producer from 1896 to 1915. Some tungsten was produced. The gold production was valued at $400,000. The property is now idle.

Mine and Plant. The deposit is a small vein in schist, and the ore occurs as free gold and scheelite. It is opened up by a 500-foot shaft, numerous drifts, and stopes. A three-stamp mill and cyanide plant treated the ore.

Bibliography. Boalich and Castello 18, p. 12; Brown, G. C. 16, pp. 512, 522; California State Division of Mines 13, no. 7; Fink, C. G. 16, p. 688.

Toboggan Group

Location. Sec. 20, T. 30 S., R. 41 E., M.D. This group of claims is located in the Atolia district, about half a mile south of the Atolia mill.

Owners. Elmer Beebe et al., Atolia.

Production History. A small lot of high-grade ore was obtained from near the surface in a pocket, and lessees have recovered some high-grade placer gravel and coarse float. The property is now idle.

General Geology. The ore is scheelite, which occurs in quartz veins in a granite country rock.

Bibliography. Cloudman, Merrill, and Huguenin 19, p. 839; Fink, C. G. 16, p. 687.

Treasury Group

Location. Sec. 21, T. 30 S., R. 41 E., M.D. This group of claims adjoins the Atolia and Osdick groups on the south and east.

Owners. (1916) D. V. McBride, M. H. Elliott, and C. W. Peterson.

Production History. A small production was made in 1916 by 26 sets of lessees. The deposit is now idle.

General Geology. The property is located on placer ground, similar to the "spud patch." The bedrock is at an average depth of 20 to 25 feet, with a minimum depth of 12 feet and a maximum depth of 54 feet.

Bibliography. Boalich and Castello 18, pp. 13; Cloudman, Merrill, and Huguenin 19, p. 839; Tucker and Sampson 30, p. 295.

Winnie Mine

Location. Sec. 11, T. 30 S., R. 40 E., M.D. This prospect is located about 3 miles southwest of Johannesburg in the Atolia district.

Owner. C. A. Koehn, Randsburg.

Production History. This mine was a small producer in 1896, 1914, and 1937. Gold was the main product, but minor amounts of tungsten were also produced.

Mine and Plant. The ore is a free-milling gold-quartz, carrying small amounts of scheelite. It occurs in small parallel veins in schist. The mine is opened by shafts from 50 to 250 feet deep. The ore was shipped to a custom mill for treatment.

Bibliography. Boalich and Castello 18, p. 13; Brown, G. C. 16, pp. 513, 522; California State Division of Mines 13, no. 10; Symons, H. H. 38, p. 173.

Yellow Aster Mine

Location. Sec. 2, T. 29 S., R. 40 E., M.D. The mine is located to the south of and overlooking the town of Randsburg.

Owner. Yellow Aster Mining and Milling Company, Los Angeles.

Production History. This property is the oldest mine of the district, and one of the three large producers. It is primarily a gold mine; but during the World War, when tungsten sold for such high prices, scheelite was recovered and shipped. Since that war, there has been no scheelite production. The mine is now being worked for its gold ores.

General Geology. The tungsten-bearing mineral was scheelite, which was found in quartz veins cutting quartz monzonite.

Bibliography. Hulin, C. D. 25, pp. 121-125.

Bishop District

This district is the second most important tungsten-producing area in the State, and 1939 production figures may show it to be ahead of Atolia. There are six operating mines in the area. The mines are located to the west of Bishop, in a low range of hills known as Tungsten Hills, at an elevation of 5,000 to 6,000 feet, and in the Sierra Nevada as high as 12,000 feet. One deposit is located to the north about 8 miles southwest of Benton. No railroad serves the area, but it is accessible by a paved highway from the south. The mines at the lower altitudes are open throughout the year, but the higher mines are snowed in during the winter.

This district was first developed during the World War. From 1922 to 1938 there was some activity, but not until 1938 did this district become of real importance as a tungsten producer. In 1938 several old mines were reopened and a great deal of activity was resumed.

The Pine Creek tungsten deposit is the largest producer and it is believed that it may surpass the Nevada-Massachusetts mine at Mill City, Nevada, within a few years, becoming the leading tungsten producer in the United States. The deposits in Tungsten Hills are considered to be nearly mined out; but large deposits are being prospected and developed higher in the Sierras, so that production may be expected to continue from this district.

Adamson Tungsten Deposit

Location. Sec. 34, T. 6 S., R. 30 E., M.D. This deposit, comprised of eight claims, is located on Morgan Creek and is approximately 21 miles (airline) west of Bishop. It is in the same pendant as the Pine Creek tungsten mine, and is about 2,000 feet above it. It is accessible by a good trail.

Owner. D. B. Adamson, Bishop. Property under lease to W. B. Lenhart and C. F. Johnston, of Bishop.

Production History. There has been no production reported from this deposit. It is now idle.

General Geology. The deposit consists of three vein-like orebodies in a roof pendant of the great Sierra batholith. One vein carries 1 percent scheelite, and has been traced for 2,500 feet. It varies from 4 to 30 feet in width. To the east 1,500 feet there are two parallel outcrops approximately 20 feet in width, reported to carry 2 percent scheelite. Another smaller outcrop, 25 feet in width and 225 feet long, reportedly carries 1½ percent WO_3.

Mine and Plant. There is no mill, and very little development has been done. The above-mentioned veins have been proven by shallow trenches. In 1938 the lessees were reported to be ready to develop the property, but in 1939 no real development had been done.

Bibliography. Tucker and Sampson 38, p. 462.

Bishop Tungsten Company

Location. Sec. 25, T. 7 S., R. 32 E., M. D. This mine, also known as the Rossi mine and the Mineral Dome prospect, is 3 miles south of Bishop, Inyo County. It lies at the base of a granite ridge, at the edge of the alluvium of Owens Valley.

Owner. Joseph Rossi, Bishop. At present A. T. Wilkerson and R. H. Moore, of Bishop, have the property, which consists of 28 acres of patented land and 4 mining claims, under lease and option.

Production History. There was a reported production from this mine in 1937 and again in 1939. A. T. Wilkerson reports that a rich strike has been made on the Phelps claims on Hilton Creek, 30 miles north of Bishop. The company has an option on these claims and 12 men are employed at the property. The company also has under lease several claims in the Benton area south of the Black Rock mine. The ore is in tactite. There are 8,000 tons of probable ore in sight, and a possible 20,000 more on the property. These claims are known as the Coos claims. In September 1940 there were 25 men employed on these claims.

General Geology. The ore-bearing zone trends westward. It consists of a belt of garnetiferous rock 600 feet long and, in places, 50 feet wide. The country rock is an altered granite which contains muscovite and micaceous veinlets. The ore layer dips southeast and is terminated by the granite. The ore consists of scheelite in an intergrowth of biotite, muscovite, magnetite, quartz, and epidote. Some chrysocolla and chalcopyrite are present.

Mine and Plant. This property is developed by a 60-foot adit and a series of opencuts. One opencut above the portal of the tunnel is about 12 feet wide, 30 feet long, and 20 feet high. The mill is located about 3 miles southeast of the mine and half a mile west of the highway.

The ore is first broken in an 8-inch by 8-inch jaw crusher. Next it is taken to a fine ore bin by an elevator. Then it is passed over a 12-mesh vibrating screen. The oversize is passed through a 3-foot by 3-foot low discharge ball mill. The product from this mill and the undersize from the screen are then treated on two Overstrom tables in series. The concentrates are then treated by an electric dryer and a Stolle electrostatic separator. A 70 to 72 percent concentrate is claimed. The mill has a capacity of about 30 tons per day. Seven men were employed in 1937 at the mine.

Bibliography. Knopf, A. 17, p. 248; Mining Journal, The 40; Symons, H. H. 38, 173; Tucker and Sampson 38, p. 462.

Boyd and Welch

Location. NW¼ Sec. 8, T. 7 S., R. 32 E., M. D. This prospect is located in the Tungsten Hills district west of Bishop, Inyo County.

Production History. There has been no production, and the prospect is generally considered to be a poor one. It is not operating at the present time.

Bibliography. Knopf, A. 17, p. 230.

Chipmunk Deposit

Location. NW¼ Sec. 33, T. 7 S., R. 32 E., M. D. This prospect consists of 9 claims in two groups at an altitude of 6,000 feet, in the second canyon south of Bishop Canyon, Inyo County.

Production History. There has been no reported production from this prospect. The property is not operating, but is optioned to N. C.

Aldo and Associates, 6769 Sunset Boulevard, Hollywood, California. It may open this summer. There is no road to it, and an aerial tram is necessary to gain access to the deposit.

General Geology. The general country rock is a coarse, white granite; but in the vicinity of the prospect, it is a gray quartz monzonite. The scheelite ore occurs in shoots in a block of sedimentary limestone which has been marbleized. The ore is highly garnetiferous and contains epidote, hornblende, quartz, and calcite. The scheelite is irregularly disseminated throughout the rock, in large particles and crystals up to 1½ inches in diameter. Magnetite, pyrite, pyrrhotite, sphalerite, and chalcopyrite are present in small amounts.

Bibliography. Knopf, A. 17, pp. 247-248.

El Diablo Mining Company

Location. Secs. 13, 14, T. 7 S., R. 31 E., M. D. This property, formerly known as the Jack Rabbit and Little Sister group of the Tungsten Mines Company, was one of the first deposits opened in the Bishop district. It is situated 8 miles west of Bishop, in the Tungsten Hills.

Owner. J. V. Baldwin, Los Angeles; property leased to H. O. Johanson of Bishop.

Production History. This property is one of the main producers in the Bishop district. It was first developed in May of 1916, and it maintained a production throughout the World War period under the supervision of the Tungsten Mines Company. In 1938 the property was sub-leased by H. O. Johanson, who started production for the first time since the World War period. The peak of production was in 1918, when 71,125 tons of ore were milled and 674,700 pounds of concentrates, averaging 61.9 percent WO_3, were produced.

General Geology. The main orebody is located on the Jack Rabbit claim. It is near the east margin of a relatively large mass of metamorphosed sedimentary rocks surrounded by quartz diorite. These rocks consist of limestone, calc-hornfels, sillimanitic quartzite, siliceous conglomerate, and metamorphosed shale. The beds dip vertically and have been cut by narrow aplite dikes which are parallel to the stratification. The ore consists of scheelite in a gangue of garnet, quartz, and epidote. Black sphalerite, pyrite, and molybdenite occur in small amounts. Minor constituents of the rock, which are distinguishable only under the microscope, are hornblende, pyroxene, calcite, and apatite. The quartz predominates and gives the ore a siliceous appearance which is different from the other ore of the vicinity. The scheelite is conspicuous, and occurs in definite shoots in the tactite. These deposits do not carry to depth and are considered to be nearly worked out.

Mine and Plant. The ore is opened by two adits intersecting a shaft, one at a depth of 60 feet and the other at 200 feet. The mill is of the gravity-concentration type, and handled 300 tons a day during the World War period. The ore is crushed by jaw crushers and rolls, and then treated by tables. The mill was designed to treat 14-mesh material. A tramway was used to bring the ore from the mine to the mill. The old mill tailings are now under lease to R. A. Stolle, who is operating on the adjacent old Aeroplane group.

Bibliography. Boalich and Castello 18, p. 14; California State Division of Mines 13, no. 101; no. 110; Fink, C. G. 17, p. 725; 18, p. 702; Hess, F. L. 21, p. 938; 21a; Hess and Larsen 22, pp. 271-273; Knopf, A. 17, pp. 230, 245; Tucker, W. B. 26, p. 512; Tucker and Sampson 31, p. 304; Waring and Huguenin 19, p. 133.

Mac Van Claim

Location. SE¼ Sec. 2, T. 8 S., R. 32 E., M.D. This claim is located 1½ miles up the canyon of Rawson Creek, Inyo County.

Owner. Mr. Mac Van; located May, 1916.

Production History. There has been no reported production from this claim. The property is now idle.

General Geology. The general country rock is a coarse white granite which contains small bodies of diorite. In these diorite bodies are small inclusions of metamorphosed limestone, most of which are not over a few cubic yards in volume. This tactite rock is composed primarily of garnet and epidote, and carries a little quartz and scheelite.

Bibliography. Knopf, A. 17, p. 248.

Morris Claims

Location. Sec. 23, T. 3 S., R. 31 E., M.D. These claims adjoin the Black Rock mine to the south. The property is owned by Sam Morris and associates. Two open cuts and an adit in tactite have failed to uncover any ore.

Bibliography. Lemmon, D. M. 40b, p. 591.

Pine Creek Tungsten Mine

Location. Sec. 31, T. 6 S., R. 30 E., M.D. This group of 12 claims is located on Morgan Creek near the crest of the Sierras, about 20 miles (airline) west of Bishop. It is readily accessible by a good road, except in winter, when it is snowed in. The mine is at an elevation of 11,000 feet.

Owner. United States Vanadium Corporation, R. J. Hoffman, president. The office is at 30 East 42nd Street, New York City. The superintendent is M. N. Shaw of Bishop. The mine was formerly operated by the Tungsten Products Company.

Production History. The deposit was first located in 1918. A mill was built and a small production was made in 1918 and 1919. The mine remained idle until 1924. Production was maintained in 1924, 1925, 1926, 1933 and 1934. The property was then obtained by the United States Vanadium Corporation, who built a mill in 1937. Production was resumed in 1938. The property is now operating and bids to become the largest producer in California; it has possibilities of becoming the largest producer in the United States.

General Geology. This orebody is a typical contact-metamorphic type. It occurs along the edge of a large pendant of metamorphosed sedimentary rocks between a dolomitic footwall and a granitic hanging wall. The orebody is vein-like and strikes north. It varies in width from 15 to 50 feet. The ore consists of scheelite, molybdenite, and chalcopyrite, with a little silver and gold, in a garnetiferous gangue. In general, the scheelite occurs in high-grade bodies near the footwall, and the molybdenite is found nearer the hanging wall. The ore is reported to assay $1\frac{1}{2}$ percent WO_3, 1 percent MoS_2, 1 percent copper, $\frac{1}{2}$-ounce silver, and $\frac{1}{2}$-ounce gold per ton. There are two orebodies separated by a 200-foot barren zone, having an aggregate length of 1,000 feet. There is reported to be 1,000,000 tons of ore developed, averaging 0.6 percent WO_3.

Mine and Plant

The mine is opened by a crosscut adit driven 2,500 feet into the hillside. At 1,700 feet a drift to the south has opened up an orebody which is mined by a combination shrinkage and sub-level caving system. At 2,500 feet a second orebody is developed by a series of crosscuts, raises and sub-levels. An upper adit 300 feet below the lower one has developed this north ore body above an elevation of 11,300 feet. The orebody above this adit is also developed by a series of crosscuts, raises and sub-levels. The surface plant consists of a blacksmith shop, machine shop, compressor house, change house, assay office, bunk houses and cottages for the employees. All power is electricity supplied by the California Electric Power Company.

A mill is located 400 feet below the lower adit. The ore is trammed to the ore bins by storage battery locomotives and eight-car trains. The primary crushing is done by an 18 x 36 jaw crusher. The secondary crushing is done by a 4-foot Symons cone crusher. The ore is then stored in a fine-ore bin, fed into ball mills in closed circuit with classifiers and ground to 65 mesh. A rougher sulphide flotation concentrate carrying molybdenite and chalcopyrite is made. This concentrate is cleaned once and a copper molybdenum separation made.

The sulphide tailings then go to scheelite flotation and a low-grade scheelite flotation concentrate is made. This concentrate is pumped to Deister tables and a high-grade tungsten concentrate is taken off. The tailings from the table are thickened, filtered and sent to a chemical plant.

This chemical plant receives these low-grade concentrates, the tungsten is removed from the ore and reprecipitated as a calcium tungstate. In the fall of 1940, at an elevation of 8,000 feet, the construction of a 1,000-ton concentrator was started. It is proposed that a 2-mile aerial tramway will convey the ore in $1\frac{1}{4}$-ton buckets to the mill from the mine.

This mill will duplicate the flow sheet of the present concentrator and chemical plant. The chemical plant section of this new mill was put into operation the first of May, 1941.

Bibliography. California State Division of Mines 13, no. 108; no. 111; Hess and Larsen 22, p. 273; Hess, F. L. 34, pp. 426-427; Knopf, A. 18, p. 124; Ridgway and Davis 38, p. 569; Symons, H. H. 34, p. 187; 35, p. 306; 38, p. 173; Tucker, W. B. 21, pp. 301-302; 24, p. 191; 26, p. 511; Tucker and Sampson 38, p. 465; Young, G. J. 26.

Round Valley Tungsten Mine (Stevens, Borchim and Shively Groups of Claims)

Location. SE$\frac{1}{4}$ Sec. 34, T. 6 S., R. 31 E., M.D. The 8 claims which comprise this mine are situated on the north slope of Tungsten

Hills, on the edge of Round Valley, 11 miles northwest of Bishop. The mine is at an elevation of 5,350 feet, and is readily accessible by road.

Owner. Western Tungsten Corporation; Ralph Merritt, president; J. E. Riley, Bishop, vice-president; Clifford H. Marker, secretary; L. C. Penhoel, consulting engineer; address, Bartlett Building, Los Angeles, California.

Production History. This property was located in 1916 as the Noble mine. It was purchased by the Round Valley Tungsten Company in 1917, and milling operations were started in August of 1917. Production was reported in 1917 and 1918. In 1918 there were 31,748 tons of ore milled. There was a small production in 1928, 1929, 1930, 1931, and again in 1938. The deposit was for a time idle, but at present 12 men are employed.

General Geology. The ore deposit is in a body of metamorphosed sediments about 4,000 feet long and 1,000 feet across. The beds dip from 40° to 60°. The country rock is granite. The sediments are composed of micaceous schists, quartzites, tactite, and marble. The body of sediments has been intruded by two dikes of andesitic rock, as well as the granite. The tactite which contains the ore occurs around the margin of a large marble body and interbedded with schists. The ore occurs in shoots in three ore-bearing tactite beds. These shoots are more coarsely crystalline than the barren tactite. The tactite in this deposit is richer in quartz, epidote, and phlogopite than are the deposits to the south. The ore is scheelite, which appears disseminated in a gangue of epidote and garnet with little or no quartz. The deposit is considered to be nearly mined out, although large areas of apparently barren tactite are exposed.

Mine and Plant. The main orebody was worked by a gloryhole over 100 feet across, extending from the granite to the marble across the tactite zone.* A mill was in operation during the World War, and a new mill was erected in 1938. This new mill had a 10-inch by 20-inch jaw crusher, 14-inch by 30-inch rolls, 12-mesh screen, 4-foot by 4-foot ball mill, two Overstrom tables, a rotary dryer, and a Stolle electrostatic separator. A good recovery was reported from the old mill, and a 70 to 72 percent concentrate was obtained. There are no figures available on the new mill, as it closed down shortly after opening, on account of a shortage of ore.

Bibliography. Boalich and Castello 18, p. 13; California State Division of Mines 13, no. 106; Fink, C. G. 18, p. 702; 31, p. 614; 33, p. 527; 35, p. 572; Hess, F. L. 21, p. 938; 21a, p. 977; 27, p. 466; 29a, p. 123; Lemmon, D. W. 40a, p. 512; Symons, H. H. 29, p. 193; 30, p. 210; 31, p. 209; 32, p. 206; Tucker, W. B. 21, p. 302; 26, p. 512; Tucker and Sampson 38, p. 466.

Scheelite Group

Location. Sec. 19, T. 8 S., R. 37 E., M.D. This prospect is located about 25 miles northeast of Big Pine, on the northeast flank of the Inyo Range overlooking Eureka Valley, Inyo County. The group of claims is at an elevation of 6,700 feet.

Owners. (1918) S. G. Drouillard, F. L. Over, and W. H. Leffingwell, of Bishop.

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* *Author's note:* In 1940 the underground workings were increased to three adits and a 65-foot shaft. Ore was being hoisted from the shaft.

Production History. Four hundred pounds of 40 percent scheelite ore were reported to have been taken out in 1907. There has been no production since then.

General Geology. Scheelite is found in the footwall side of a copper-bearing vein. The vein is in granite about 100 feet above a limestone contact, and is about 12 inches in width. No development work has been done, and the prospects for a large quantity of good ore are slim.

Bibliography. Boalich and Castello 18, p. 12; California State Division of Mines 13, no. 100; Waring and Huguenin 19, p. 131.

Shannon Creek Tungsten Deposit

Location. SW¼ Sec. 20, T. 8 S., R. 33 E., M.D. This deposit is located on Shannon Creek, about 4 miles north of Big Pine, at an elevation of approximately 5,700 feet.

Ownership. In 1916 the property was under bond and lease to Charles W. Alvord, Bakersfield.

Production History. There was a small production reported from this deposit in 1916. The property is now idle.

General Geology. This deposit is located in a small knob of altered limestone and granite which protrude from the alluvium of Owens Valley. The limestone is altered to an epidote-hornblende rock, and the granite is highly epidotized. The ore is scheelite, and is reported to be of a very high grade in places. Minor constituents are chlorite, pyroxene, garnet, magnetite, titanite, and apatite. There are two reported oreshoots, but the prospects for the deposit are not considered favorable.

Bibliography. Boalich and Castello 18, p. 12; California State Division of Mines 13, no. 98; Knopf, A. 17, p. 248; Tucker and Sampson 38, p. 467; Waring and Huguenin 19, p. 131.

Tungstar Mine (Crawford Deposit)

Location. Sec. 10, T. 7 S., R. 30 E., M.D. This deposit is located 2 miles southeast of Big Pine Creek on Mount Tom, at an elevation of 12,400 feet.

Owner. Cord Crawford, Bishop, California. Property under option to Tungstar Mining Company, 6233 Hollywood Boulevard, Los Angeles, California. Reginald Owen, president; P. N. Stevens, secretary and manager; Bemis Phelps, consulting engineer.

Production History. This deposit has had a small production, but no figures are available.

General Geology. This deposit carries from 2 to 5 percent WO_3, in a rather extensive tactite body 40 feet in width. It is estimated that from 10,000 to 15,000 tons of ore are exposed.

Mine and Plant. The mill, with a capacity of 100 tons, is located at an elevation of 10,000 feet, and is connected to the mine by an aerial tramway. The property was operating in 1939.

Bibliography. Lenhart, Walter B. 41, p. 67; Tucker and Sampson 38, p. 464.

Tungsten City Milling Company

Location. Sec. 13, T. 7 S., R. 31 E., M.D. This property, formerly known as the Aeroplane group and the Standard Tungsten Company, is located 8 miles west of Bishop in the Tungsten Hills. It is adjacent to the property of El Diablo Mining Company.

Owner. J. V. Baldwin, Los Angeles; property under lease to Raymond A. Stolle, P. O. Box 641, Bishop.

Production History. This property was one of the largest producers in the Bishop district during the World War. It is reported that 37,000 tons were milled before 1921, assaying 0.5 percent WO_3. A small production was reported in 1922. A new mill was built early in 1937, and was treating material in 1940. The new mill treated tailings from the mill of the old Tungsten Mines Company, as well as from the old Standard mill. No mining has been done at the property during the past few years, and it was reported to be still inactive in June 1940.

General Geology. The ore is in an outcrop of metamorphosed sedimentary rocks, about 1,300 feet long and 250 feet wide at the widest point. These rocks are interbedded quartzites, schists, and limestone, which is mostly altered to tactite. The country rock surrounding the pendant is granodiorite. A generalized cross-section of the body shows 40 feet of quartzites and hornfels, 30 feet of tactite, 20 feet of quartzite and schist, 40 feet of tactite, and quartz-diorite. All the tactite is not ore; the scheelite occurs in regular shoots which cannot be traced except by panning or testing with ultra-violet light, on account of the minor amounts of scheelite present. The tactite is a dense brown rock made up mostly of garnet, with some quartz, calcite, epidote, scheelite, apatite, titanite, and a variable amount of amphibole, pyroxene, sphalerite, and pyrite. Three other tactite bodies were mined in the vicinity, each of which was found in a small pendant of metamorphosed sedimentary rocks in the quartz-diorite. These are the Deep Creek, Greenhorn, and Brockman workings.

Mine and Plant. The main workings are in the Aeroplane group, and are worked through a glory-hole that is 175 feet long and 30 feet wide at the outcrop. The maximum depth of the hole is 145 feet. The glory-hole is cut at depth by an adit through which the ore is hauled to the mill. The mill is below the mouth of the adit in the canyon. The old mill treated the ore on an Isbell table, and lost 35 percent of the scheelite in the tailings. In 1937, R. A. Stolle rebuilt the mill to treat the old tailings.

The new mill is a dry plant. A caterpillar tractor and a drag-line bring the old tailings to the mill bin. The material is then put through a 12-mesh screen. The oversize is saved, to be ground later. The undersize is sent to Stolle electrostatic separator. The tailings are taken out by a conveyor system. The capacity of the mill is 120 tons per day, and a 70 to 72 percent concentrate is reported. There is no mining being done, and the treatment of the old tails constitutes the entire activity.

Bibliography. Boalich and Castello 18, p. 14; California State Division of Mines 13, no. 96; no. 109; Fink, C. G. 17, p. 725; 18, p. 701; Hess, F. L. 21, p. 938; Hess and Larsen 22, p. 270; Knopf, A. 17, pp. 231, 243; Lemmon, D. W. 40a, pp. 507-509; Tucker, W. B. 21, p. 303; 26, p. 512; Tucker and Sampson 38, pp. 464, 467; Waring and Huguenin 19, p. 119.

Tungsten Mining Company

Location. This property of 16 claims is located in the Coyote district west of Bishop, California.

Owner. A. L. Crowthers, president and general manager; Jack Peters, mill superintendent; address, 1954 Estrella Avenue, Los Angeles.

Production History. This property has been producing tungsten and garnet concentrates from a plant built in December 1940. Seven men are employed.

Bibliography. Mining Journal, The 41.

West Tower Claims

Location. Sec. 3, T. 3 S., R. 31 E., M.D. These claims are owned by J. W. Otey and are located near the northern limit of the metamorphic rocks. A shaft and a few shallow pits failed to uncover any ore. Scheelite is the ore mineral, and is found in small tactite bodies.

Bibliography. Lemmon, D. M. 40b, pp. 592-593.

Kernville District *

This district is located in the southern Sierra Nevada, in the vicinity of the town of Kernville. It includes the Greenhorn district to the west. The deposits lie in two belts. One belt extends from north of Kernville past Isabella, Bodfish, and Havilah to Caliente. In this belt are included the deposits near Weldon. The other belt is on the western slope of the Greenhorn Mountains, near the summit along Cedar Creek. The area is reached by good roads. It is extremely mountainous, and many deposits are accessible only with difficulty. In the winter the mountains are covered with snow, when many deposits are inaccessible. In the summer the weather is warm and pleasant.

Claims are numerous, but few deposits have thus far been developed or worked. Activity now is confined to the work of a few prospectors and one operator with two lessees. Another deposit is just being opened, and a mill is being erected. This district has had a small production, but it seems to offer the best possibilities for prospecting in the State. There are numerous tactite deposits along a belt of limestone some 50 miles long and a mile wide. Comparatively little work has been done, due primarily to the inaccessibility of the region. However, if a large enough deposit were found and proved, a road could be built without too much difficulty.

Cadillac Claim

Location. Sec. 7, T. 25 S., R. 32 E., M. D. This claim is located on the north fork of Cedar Creek, about 2½ miles above the county road.

Owners. (1916) Mr. and Mrs. O. G. Wood, Glennville.

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* *Editorial note (April 20, 1941):*

A new report (which was not available to the author) has now been issued by the California State Division of Mines which describes the mineral resources and geology of the Kernville quadrangle, Kern County. It includes several tungsten properties (Tucker and Sampson 40, pp. 331-333; Miller and Webb 40).

Production History. No production has been reported from this claim. It is now idle.

General Geology. The deposit is an unevenly metamorphosed limestone, and has been exposed for from 30 to 40 feet along the bank of the stream. The minerals are epidote, garnet, and quartz. Considerable pyrite was found in one opening, and scheelite is present in small quantities. The ore is said to assay from 0.25 to 0.5 percent WO_3.

Bibliography. Hess and Larsen 22, p. 265; Storms, W. H. 16.

Corporal B. E. K., Texas Star No. 1 and No. 2 Claims

Location. This deposit is about 1 mile south of the Wall Street group and about half a mile east of the main county road from Havilah to Caliente.

Owners. T. J. and N. T. McKee.

Production History. There has been no production from this deposit.

General Geology. This deposit consists of three claims along the same tactite dike as the Wall Street group to the north. The dike is nearly vertical, and lies between schist hanging and footwalls. The tactite grades into a hard gray, green, or red marble. The scheelite occurs in a soft brown garnet rock. Ore has been traced for 3,000 feet along the outcrop, and is said to average 1.5 percent WO_3. There is a high-grade kidney of ore reported from the top of the hill above the adit, assaying 11 to 12 percent WO_3. An adit is being run from the bottom of the canyon into the hill under this high-grade kidney. A small mill to treat the ore is also planned. There has been no further prospecting or development work done. This property is considered to be a fair prospect.

Good Hope and Little Dick Group

Location. Sec. 23, T. 25 S., R. 33 E., M. D. This deposit is located about 2 miles northeast of Kernville, about half a mile east of the county road. The deposit is accessible by a fair road.

Owner. C. W. Pascoe, Kernville, California. The property has been leased by Mr. C. J. Gusty, of Kernville, who has sub-leased the deposit to two men who carry on the mining operations. Mr. Gusty operates a small mill which treats the ore from the mine.

Production History. The mine is now producing a small amount of tungsten concentrates. It is estimated that there are between 500 and 1,000 tons of ore left in place.

General Geology. The ore is scheelite in a typical contact-metamorphic deposit. The deposit is in a pendant of altered sedimentary rocks which cap a small hill. The tactite occurs in small lenses in a hard, gray, garnetized and epidotized marble. The tactite is brown in color and generally friable. Garnet and epidote are the principal minerals with minor quartz, calcite, scheelite, and hornblende. The ore carries about 1 percent scheelite, which is present in large grains. The country rock, which surrounds the deposit and forms the base of the hill beneath the pendant is diorite. The deposit cannot be expected to carry to depth, as the pendant is cut off by the diorite.

Mine and Plant. The deposit is opened by drifts and opencuts which are developed in the small lenses. The miners pick an outcrop of tactite and then mine out the entire lens. A small compressor and a jack hammer are used to break the ore. The ore is hauled to the ore chute by wheelbarrow, and a truck carries it to the mill.

The mill has a capacity of 10 tons per day. The mill equipment consists of a small jaw crusher, ball mill and vibratory table. The entire mill is operated by a 1-horsepower diesel engine, at a fuel cost of $0.50 per day. This mill is easily moved in a truck. The ore for one day's run is first crushed in the jaw crusher and passed on to the fine ore bin. The belt is then transferred over to the ball mill and vibratory table which are operated simultaneously. The ball mill is fed from the fine ore bin by an automatic feeder. The mill product is then passed over the table, from which three products are taken—a concentrate, middling, and tailing. The tailing is discarded. The middling is repassed over the table, and the concentrate is saved. The concentrate is reported to be over 60 percent WO_3, and is sacked and shipped. Although no figures are available, the tailings seemed to contain a fairly high percentage of scheelite.

Herschel Kelso Claim

Location. Sec. 17, T. 25 S., R. 32 E. M.D. This claim is located at the head of Cedar Creek, on the top of the Greenhorn Mountains.

Owners. (1916) R. A. Brown, A. M. Kidd, M. W. Pollock, and George S. Seib.

Production History. Small amounts of ore were taken to the nearby Rand Mining Company mill, and a small quantity was sacked for shipment in 1917. No other production was reported. The claim is now idle.

General Geology. The ore is a tactite having an outcrop 100 feet by 200 feet, along the largest dimensions. The rock is friable and fine grained. Epidote is the principal mineral, and quartz fills the interstices. There are small flakes of biotite and some red-brown garnet. Scheelite is the tungsten-bearing mineral, and is in grains from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch in diameter. The ore is said to average 2 percent WO_3.

Bibliography. Hess and Larsen 22, pp. 264-265.

Rand Group

Location. Secs. 19, 20, T. 25 S., R. 32 E., M.D. The claims of this group are located on Cedar Creek in the Greenhorn Mountains.

Owner. Rand Mining Company operated the mine until July 1, 1917. It was then transferred to Gus Schamblen of Bakersfield. In October, 1917, it was being worked by Charles Guzman and associates. It is now idle.

Production History. The only reported production was in 1917; and the amount produced was not reported, although it is known that hand jigs produced 500 pounds of concentrates.

General Geology. This deposit is a typical contact-metamorphic deposit composed of three zones: (1) dark-silicate, (2) light-silicate, and (3) marble. The country rock is a light-colored quartz diorite containing both biotite and hornblende. Near the contact, these dark minerals increase in proportion. The deposits are in a limestone bed which strikes north and dips vertically.

The tactite or dark-silicate zone contains quartz, biotite, garnet, epidote, lime feldspar, pyrrhotite, pyrite, and chalcopyrite. At the surface the iron sulphides are altered to limonite. Some flecks of molybdenite were also found. At the surface the scheelite was coarse-grained and abundant, the ore running 30 percent WO_3; at the bottom it had dwindled to less than 1 percent. Below the oxidized zone the gangue was almost solid pyrrhotite with a little pyrite. Wollastonite was the chief mineral of the light-silicate zone.

Mine and Plant. An opencut 20 feet deep and 6 to 10 feet wide was made on the deposit, and also a 50-foot shaft. The ore shoot was estimated to be 30 feet in length and 6 to 8 feet in width. A small mill was finished in July of 1917. The mill consisted of a 12-inch by 16-inch Blake crusher; Allis-Chalmers style C rolls; a 20-mesh screen, 4 feet long by 3 feet wide; a Wilfley No. 3 concentrating table and elevator; and a Marathon 20-inch mill. The concentrates were roasted and shipped to San Francisco for electromagnetic separation.

Bibliography. Hess and Larsen 22, p. 263.

Tungsten King Mine

Location. Sec. 26, T. 27 S., R. 32 E., M. D. This mine is located on the east slope of Bald Mountain, about 2½ miles northeast of Havilah and about half a mile west of the county road from Isabella to Havilah. It is accessible by winding road and a tramway.

Owner. Fairfield Mining and Milling Company, Laguna Beach. The company is headed by Ted Cook, George Horrell, and Mr. Sutton. George Smith of Weldon is in charge of operations, and Ralph Ralston serves as superintendent.

Production History. A small production was reported from nearby claims in 1917, and again in 1929. At present 30 men are employed in mining and milling operations.

General Geology. Bald Mountain is primarily dark biotite granite traversed by several long, wide quartz seams. The quartz is glassy and coarsely crystalline, and closely resembles the bull quartz of the Mother Lode. Scheelite is disseminated throughout the quartz in masses, and also in large crystals. The ore is reported to average from 1 to 2 percent WO_3. There are also small amounts of pyrite in the ore. One vein has been opened in several places, and has been traced for more than a mile toward Havilah. The mine can be considered only a prospect, and the prospects for a large amount of workable ore are not too favorable.

Mine and Plant. A 75-ton mill has been completed and is operating on a two-shift basis. The mill is handling ore from five properties of the company, the Flatiron, Clear Creek, Tungsten King, Big Lode, and Miranda.

Bibliography. **Mining Journal, The 41.**

Wall Street Group

Location. Sec. 33, T. 28 S., R. 32 E., M. D. This deposit is located about 5 miles south of Havilah in the Red Hills, and about half a mile northeast of the county road. It is accessible by a poor road.

Owner. C. J. Gusty, of Kernville. Mr. Gusty operated his mill on the property for a short time in 1939.

Production History. A small production was made in 1918 and again in 1939. The property is now idle, as a result of the mill-site litigation.

General Geology. The ore is a garnetiferous tactite which lies between a marble and a garnet-mica schist. It lies in a belt of sedimentary rocks which strike roughly north, and which are traceable from north of Kernville to below Monolith. Limestone and schist are the two types of rock in the belt, and tactite is developed locally along the contact. The country rock is a biotite granite. The tactite has been cut by a quartz vein in which large crystals of epidote have been developed. Brown garnet, epidote, quartz, calcite, and scheelite are the important minerals. The ore is reported to carry from 0.5 to 1 percent WO_3, but no accurate sampling of the deposit has been done. There may be a considerable amount of ore here, but additional prospecting is necessary before the deposit can be called more than a prospect.

Mine and Plant. The development consists of a few trenches and deeper cuts where pockets of ore were mined. There is no mill.

Bibliography. California State Division of Mines 13, no. 148; Tucker, W. B. 21, p. 316.

Weldon District

Just south of Weldon, Kern County, there are several deposits of the contact-metamorphic type. Although no production has been made from these deposits, they are all covered by claims and some may be large enough to warrant mining. They are accessible with difficulty. The greater number of the deposits are in the basin of Kelso Creek, and are scattered along a belt several miles long.

These prospects are near the contact of a large body of granite and granodiorite on the east, and altered sedimentary rocks on the west. The contact follows along the strike of the bedding in a general northerly direction. The deposits are in small patches of sedimentary rocks entirely surrounded by the granitic intrusive, and are developed in altered limestones which are interbedded with shales and quartzite. The ore occurs in a tactite around the margin of the limestone inclusion. This tactite zone is followed by a light silicate zone and a marble core. The chief minerals of the tactite are quartz, calcite, pyroxene, hornblende, sphalerite, epidote, brown garnet, montronite (or chloropal). Other minerals include some titanite, apatite, mica, feldspar, scheelite, chrysocolla, pyrite, chalcopyrite, and molybdenite. In the light-colored zone the chief minerals are calcite, tremolite, colorless garnet, colorless pyroxene, scapolite, mica, and apatite. The tenor of the ore is generally about 1 percent WO_3.

North of Weldon is a claim owned by A. B. Cohen of Los Angeles; and just to the east of this claim are a number of claims owned by Joe

Victor of Isabella. About 3 miles to the northeast are the claims of the Kelso Mining Company. The largest tactite deposit of the district is covered by the claims of Stephen and Creighton, and Duarte and Hall. This deposit is about 5 miles southeast of the claims of the Kelso Mining Company. Wade J. Gessel, of Weldon, has a claim in the same area south of Weldon.

Why Not Claim

Location. Sec. 19, T. 25 S., R. 32 E., M. D. This claim is located on Cedar Creek in the Greenhorn Mountains.

Owner. (1916) J. R. Rogers.

Production History. Small production was made in 1916, but no record of the amount is available. The deposit is now idle.

General Geology. The ore is a typical tactite of the contact-metamorphic type. The rock is soft and friable, and dark brown in color due to limonite staining. The deposit seemed to be faulted and cut by granitic dikes. Quartz, epidote, garnet, hornblende, and calcite with some pyrite and secondary limonite are the chief constituents of the rock. Scheelite is present in small amounts and is generally invisible, although some crystals nearly one-half inch in diameter were found. The only working is an excavation about 15 feet wide.

Bibliography. Hess and Larsen 22, p. 264.

EASTERN SAN BERNARDINO COUNTY DISTRICT

This district comprises the New York Mountain, Clark Mountain, and Signal districts. It is accessible by the Atchison Topeka and Santa Fe and the Union Pacific railroads as well as by good roads. Goffs is the nearest town to the Signal district, and Ivanpah is just to the north of the New York and Clark Mountain districts. The region is a desert with high ranges rising from the floor. Vegetation is sparse. Water is scarce and must be hauled from wells. In summer the temperature frequently reaches 120° F., and seldom falls below 100° F. The winters are cold and strong winds sweep the desert from the west and southeast.

During the World War there was considerable activity in this area, and several tungsten deposits were opened. A small production was made, but no large mines were developed. The lack of water hindered mining and milling operations. This district can not be considered a good prospecting area, and it is extremely unlikely that it will ever be an important tungsten-producing region.

Argosy Mine

Location. T. 11, N., R. 17 E., S.B. This mine, consisting of three claims, is 6 miles north of Goffs and is the southernmost mine of the district.

Owner. Mrs. Remalia, Los Angeles, California.

Production History. A small production was reported in 1916. The property is now idle.

General Geology. The ore is hübnerite and wolframite, finely disseminated in a system of veinlets in a pegmatite dike. The veinlets vary in width from 4 inches to 6 inches, strike (with the general trend of the dike) east and dip about 45° north. The ore is reported to average 2 percent WO_3.

Mine and Plant. No mill was ever erected and the ore was treated at the plant of the Louisiana-California Mining Company. The deposit was developed by an adit 140 feet long, driven on the dike, and a 38-foot raise to the surface at the face of the adit.

Bibliography. Boalich and Castello 18, p. 13; California State Division of Mines 13, no. 139; Cloudman, Merrill, and Huguenin 19, p. 844; Tucker and Sampson 30, p. 291; 31, p. 364.

Carbonate Group

Location. Sec. 23, T. 14 N., R. 15 E., S.B. This group of six claims is located in Cliff Cañon, on the north slope of the New York Mountains, 2 miles southeast of Brant, San Bernardino County.

Owners. (1916) J. R. Crawford, Matt McCarthy, and George Carruthers, of South Ivanpah.

Production History. The only reported production was in 1916, when several tons of high-grade ore were taken out. The mine is now idle.

General Geology. The tungsten-bearing mineral is wolframite. It occurs in narrow quartz veins varying from 2 inches to 1 foot in width. There are six distinct veins striking northeast, in a pegmatite dike. The quartz is very friable, and contains no impurities except for occasional pyrite.

Mine and Plant. There is no plant and the workings consist of a tunnel which intersects an 8-inch vein along which drifts have been run. Work on the other veins has been on the surface.

Bibliography. California State Division of Mines 13, no. 163; Cloudman, Merrill, and Huguenin 19, p. 841; Tucker and Sampson 30, p. 294.

Confidence Copper Mine

Location. Sec. 5, T. 11 N., R. 14 E., S.B. This mine is situated 4 miles southeast of Ames Station, San Bernardino County.

Owner. (1916) Edward Blewett of Kelso.

Production History. Small shipments of tungsten ore were made in 1918. The property is now idle.

General Geology. Tungsten occurs as wolframite in quartz veinlets in a pegmatite dike.

Bibliography. Boalich and Castello 18, p. California State Division of Mines 13, no. 187; Cloudman, Merrill and Huguenin 19, p. 849.

J. C. and W. O. Kinsman Claims

This group of claims is located about 8 miles north of Goffs, San Bernardino County. Rich tungsten ore float has been found on a number of the claims. A small amount of prospecting was done in 1916.

Lombard and Main Group

Location. Sec. 20, T. 11 N., R. 17 E., S.B. This group, formerly the California Vanadium Company, consists of a large number of claims 8 miles north of Goffs, San Bernardino County, in the Signal district.

Owners. Last reported owners were A. L. Lombard and J. F. Main Estate, Goffs.

Production History. There was a reported production from the mine in 1915 and 1916. The property is now idle.

General Geology. The ore is wolframite occurring in veins in granite. High-grade float was found in the vicinity.

Mine and Plant. Little work was done on the deposit, the development being mostly superficial. A small mill was erected, which consisted of Braun rolls and a Stebbins dry concentrator which were operated by a gas engine.

Bibliography. California State Division of Mines 13, no. 147; Cloudman, Merrill, and Huguenin 19, p. 845; Tucker and Sampson 30, p. 294.

Mojave Annex Mine

Location. Sec. 23, T. 14 N., R. 15 E., S.B. The mine is located on the north slope of the New York Mountains, 2 miles southeast of Brant, San Bernardino County.

Owner. (1916) Mojave Annex Tungsten Company; J. B. Evans, president; H. G. Parsons, secretary; office, 725 Main Street, Los Angeles.

Production History. Production of concentrates was reported in 1916, 1917 and 1920. The property is now idle.

General Geology. Wolframite occurs in quartz stringers in a pegmatite dike. The stringers range from 1 to 12 inches in width. They are parallel to the dike, which is 40 to 50 feet in width, and which dips nearly vertically. Between the stringers, shoots of quartz carry galena, ruby silver, and some copper. The wolframite occurs in disseminated crystals and in masses.

Mine and Plant. The only development is an adit driven 100 feet along the dike. A small mill, consisting of a force feed jaw crusher, Davis rolls, and a Stebbins dry concentrator, treated the ore.

Bibliography. Boalich and Castello 18, pp. 13; California State Division of Mines 13, no. 185; Fink, C. G. 16, p. 688; 18, p. 701; Tucker, W. B. 21, p. 373; Tucker and Sampson 30, p. 294.

Mojave Tungsten Mine

Location. Sec. 19, T. 17 N., R. 14 E., S.B. The mine is in the Clark Mountain district, about a mile south of Ivanpah, San Bernardino County. The mine is accessible by road from Nipton, California, or Roach, Nevada.

Owner. Was the Mojave Tungsten Company. In 1930 the Colosseum Gold Mines Corporation took over the property.

Production History. A small production was made in 1915 and 1916. The property is now idle.

General Geology. The ore is wolframite and scheelite, which occur together in a system of narrow fissure veins in granite. The ore was fairly high grade, and pockets often contained 30 percent WO_3. The gangue mineral is quartz.

Mine and Plant. A small concentration plant was erected and a large tonnage of ore was reported blocked out.

Bibliography. California State Division of Mines 13, no. 151; Cloudman, Merrill, and Huguenin 19, p. 839; Fink, C. G. 17, p. 724; Tucker and Sampson 30, p. 294.

Sagamore Mine

Location. Sec. 20, T. 14 N., R. 16 E., S.B. The mine is located on the southern slope of the New York Mountains, about 10 miles west of Purdy, at an elevation of 5,800 feet.

Owner. (1916) Ivanpah Copper Company.

Production History. A small production of tungsten concentrates was made in 1915. The property is now idle.

General Geology. This mine was originally worked for its copper ores, but was forced to close operations. Tungsten was discovered in the ore some 30 years later, in 1915. The mine re-opened, and a small mill was erected.

The ore, which occurs in well-defined quartz veins in phonolite, carries sulphides of iron, copper, lead, zinc, and antimony, with oxides of copper, rhodochrosite, wolframite, and some gold. The veins vary in width from 4 to 12 feet. The ore often forms rich streaks of various thicknesses.

Bibliography. California State Division of Mines 13, no. 156; Cloudman, Merrill, and Huguenin 19, p. 790; Hausmann, Kruttschnitt, Thorn, and Edman 08, pp. 331-333; Tucker and Sampson 30, p. 220; 31, p. 279.

Shafer, Schloerb, and Field Group

Location. Sec. 23, T. 14 N., R. 15 E., S.B. This group of five claims is located in Cliff Cañon, adjacent to the Carbonate group.

Owners. The locators of the claims were R. H. Shafer, E. W. Schloerb, and W. L. Field.

Production History. No development work or production was ever made. The workings are now idle.

General Geology. The ore is wolframite in small quartz veinlets, in an intruding pegmatite dike.

Bibliography. California State Division of Mines 13, no. 157; Cloudman, Merrill, and Huguenin 19, p. 842.

Tungsten King Group

Location. Sec. 32, T. 14 N., R. 15 E., S.B. This group of seven claims lies on the south slope of the New York Mountains at an elevation of 6,700 feet, and is 15 miles northwest of Ledge Station and 4 miles east of Cima, San Bernardino County.

Owners. (1916) J. F. Brooke, F. M. Brooke, F. W. Chausse, and J. G. Bliss, of Goffs, California.

Production History. This mine was not developed. A few tons of high-grade float were sacked and ready for shipment in 1916. The mine is now idle.

General Geology. Tungsten occurs as small crystals of hübnerite and wolframite disseminated through a pegmatite dike which ranges from 25 to 60 feet in width. The dike is said to average from 1 to 5 percent WO_3. The ore is clean and free from base metals.

Bibliography. California State Division of Mines 13, no. 159; Cloudman, Merrill, and Huguenin 19, p. 842; Tucker and Sampson 30, p. 295.

MISCELLANEOUS DEPOSITS

Tungsten minerals have been found throughout the State in other localities than those already mentioned. These deposits are scattered throughout the Sierras, eastern California, and southern California in San Bernardino and San Diego Counties. The majority of these deposits have not been worked since the World War though two mines in Tulare County are now producing. The production from them was small and, from many, was negligible.

El Dorado County

Comeback Consolidated Mine

Location. Sec. 4, T. 11 N., R. 11 E., M.D. This mine is situated near Placerville, El Dorado County.

Ownership. The mine is owned and operated as the Comeback Consolidated tungsten mine, by B. F. Magee and Lee Wolfe, of Georgetown.

Production History. Mining and shipment of tungsten concentrates were reported from this mine in 1930 and 1932. The property is now idle.

Bibliography. Symons, H. H. 32, p. 206; 33, p. 176.

Fresno County

Rhodes and Brown Deposit

Location. Sec. 29 or 30, T. 18 S., R. 13 E., M.D. This deposit is about 30 miles northwest of Coalinga, near the San Benito County line.

Owners. L. H. Rhodes and G. E. Brown, of Coalinga.

Production History. No production was ever reported; it is doubtful that any further prospecting or development has been done.

Bibliography. Bradley, W. W. 16.

Wm. Terrill Prospect

Location. Secs. 16, 17, T. 13 S., R. 25 E., M.D. This deposit is near the town of Trimmer, Fresno County.

Owner. Wm. Terrill.

Production History. There has been no production from this deposit, and it is now idle.

General Geology. The tungsten occurs as scheelite in a quartz vein. The vein strikes east, and dips to the south. The footwall is limestone; the hanging wall is granite. The vein is said to be 5 feet in width. It carries some gold. The scheelite occurs in bunches along the hanging-wall side of the vein.

Bibliography. Bradley, W. W. 16, p. 470; Laizure, C. McK. 29, p. 336.

Inyo County

Alvord Group

Location. Secs. 20, 21, T. 15 S., R. 41 E., M.D. This property is located in the Ubehebe district, south of the racetrack northeast of Keeler, about 5 miles west of Goldbelt Springs.

Ownership. This group of claims was located in 1916 by William Elliott, Ray Spear, and Rose Spear, of Lone Pine.

Production History. No production was made, and very little prospecting or development work was done.

General Geology. The tungsten occurs as scheelite on the footwall of a ledge containing copper and iron. The ledge is at the contact of a granite and a limestone, and is said to be 10 feet wide and 300 feet long.

Bibliography. Boalich and Castello 18, p. 12; California State Division of Mines 13, no. 97; Waring and Huguenin 19, p. 131.

Darwin Deposits

Location. In the vicinity of Darwin there are several tactite areas which have been prospected for scheelite. One prospect is 2 miles southeast of Darwin, and another is 5 miles south of Darwin.

Ownership. There is no record of any ownership or of any production from these deposits.

General Geology. The ore is scheelite. It is found in narrow seams of very rich ore. The seams are irregular and cut the tactite. The scheelite is associated with pyrite, chalcopyrite, chrysocolla, calcite, calamine, and gypsum. There is a little scheelite disseminated through the tactite itself, but the deposits are not typical contact-metamorphic.

There are other contact zones of good size in the vicinity; but upon testing, only traces of scheelite were found.

Bibliography. Hess and Larsen 22, pp. 267-268; Knopf, A. 18, p. 14.

Deep Springs Valley Deposit

Location. Sec. 4, T. 7 S., R. 36 E., M.D. This group of 11 claims is located 22 miles north of Zurich, in Deep Springs Valley.

Owners. (1918) D. F. Shively and W. A. Sanger, of Big Pine.

Production History. A small production was made in 1918. The mine is now idle.

General Geology. A series of parallel quartz veins, varying in width from mere seams to over 4 feet, carrying scheelite. The veins are of the fissure type and are found in granite. The general strike of the vein is northeast, and the dip is about 25° to the southeast. Outcrops can be traced across the claims, and opencuts and trenches indicate a large tonnage of quartz. The grade of the ore is not reported. The mine is now idle.

Bibliography. California State Division of Mines 13, no. 107; Tucker, W. B. 21, p. 301; 26, p. 511.

Emergency Group

Location. This group of eight claims is located in Deep Springs Valley, 6 miles west of Deep Springs School, about 22 miles northeast of Zurich, Inyo County.

Owner. Stuart Bedell.

Production History. There has been no reported production from these claims.

General Geology. The tungsten-bearing mineral is scheelite, which occurs in a mineralized belt 50 feet wide and 450 feet long. The ore is said to average 0.5 to 1 percent WO_3.

Bibliography. California State Division of Mines 13, no. 107.

Feldman Tungsten Mine

Location. Sec. 16, T. 23 S., R. 38 E., M.D. The five claims comprising this mine are located in the south end of the Coso Range, 2 miles east of Little Lake, Inyo County.

Owner. Frank Feldman, Independence, California. The property is under lease and bond to E. E. Brown, of Los Angeles.

Production History. There is no record of any production from this deposit. The mine is now idle.

General Geology. Scheelite occurs in a quartz vein ranging from 2 to 4 feet in width. The country rock is granite. The vein can be traced for 2,800 feet along its outcrop. The scheelite is crystalline, and varies in color from white to orange. The ore is reported to carry from 1 to 5 percent WO_3.

Mine and Plant. Little development work has been done. A tunnel was driven for 200 feet along the vein, and a 30-foot shaft sunk at the portal. There is no mill.

Bibliography. Tucker and Sampson 38, pp. 464-465.

Monarch Tungsten Mine

Location. T. 15 S., R. 41 E., M.D. This mine is located in the Ubehebe district, about 35 miles northeast of Keeler between Dodd's and Goldbelt Springs. There is a road from Keeler to within 4 miles of the mine.

Ownership. The property was located in 1915 by the Monarch Tungsten Company, Denver, Colorado. The president was Fred C. Allen, and the secretary and manager, Frank D. Allen.

Production History. A small production was made in 1915. The property is now idle.

General Geology. The tungsten ore is hübernite, which occurs in bunches in a fissure vein in granite. The average width of the vein is 22 inches. The vein strikes northwest and has an almost vertical dip. The hübernite played out at a depth of 50 feet, but the vein continued. The deposit is opened by a 50-foot shaft and a 250-foot drift from the shaft bottom.

Bibliography. California State Division of Mines 13, no. 99; Waring and Huguenin 19, p. 131.

Waucoba Tungsten Deposit

Location. Sec. 27, T. 11 S., R. 39 E., M.D. This deposit is made up of seven claims situated on the east slope of the Inyo Range, 22 miles southeast of Big Pine and 3 miles southeast of Waucoba Springs, Inyo County.

Owners. Stuart Bedell and Clyde McBride of Big Pine. Under option to J. L. Danziger, Glendale, California.

Production History. There has been no reported production from this deposit.

General Geology. The ore is scheelite in a belt of limestone, some 100 feet in thickness, between two beds of quartzite. This limestone bed strikes N. 30° W., and dips 50° to 60° to the northeast. To the southeast of this orebody is a massive outcrop of quartz which is mineralized with copper silicates and carbonates, and which is reported to carry $2.00 in gold. About 1½ miles north of this property, two claims have been located on a garnetiferous outcrop which is 6 feet in thickness and over 200 feet long. Scheelite occurs here, with fluorite.

Mine and Plant. The limestone body is opened by a 200-foot shaft which has exposed 6 feet of ore, assaying 2 percent WO_3. The quartz body is exposed by a 30-foot shaft. The property to the north has been developed by a series of opencuts. Six men were employed in 1940, on development work.

Bibliography. Tucker and Sampson 38, p. 467.

Kern County

Blue Point Deposit

Location. Section corner of Secs. 10, 11, 14 and 15, T. 30 S., R. 31 E., M.D., is located on one of the three claims. The deposit is accessible by a fair road from the main highway, and is about 6 miles from the line of the Southern Pacific Railroad.

Production History. There has been no appreciable production from this deposit. A few sacks of high-grade ore have been shipped, however.

General Geology. The ore is in the form of scheelite and wolframite in a belt of greisenized granite, about half a mile long and a quarter of a mile wide. The greisen is best developed along fractures in the granite. The ore occurs in a rock which is primarily muscovite with minor amounts of quartz and feldspar. The ore occurs in pockets which are generally rather small. It is not expected that a large orebody will be developed here. The pockets are scarce and widely separated. They do occur on fissures, but usually are so small as not to be worth the expense of finding them. There is no plant here, and the work is mostly superficial. Two men are operating the property at the present time.

Cecil and Clarence Pascoe Group

Cecil and Clarence Pascoe of Kernville have opened a tungsten mine opposite the properties of the Kern Mines, Inc. The ore mined will be treated in the mill of the Fairfield Mining and Milling Company.

Bibliography. Mining Journal, The 41.

Green Monster Mine

Cuproscheelite was reported to have been found with radiating black tourmaline at the Green Monster mine, about 12 miles east of White River, Kern County.

Bibliography. Eakle, A. S. 14.

J. Hodgson Claim

In 1914 J. Hodgson of San Francisco, had a deposit of tungsten ore in the form of hübnerite, about half a mile from the Granite King mine, 28 miles west of Randsburg, Kern County.

Sunset Group

Location. Sec. 6, T. 30 S., R. 40 E., M.D. This group of six claims is located 6 miles southeast of Garlock, Kern County.

Owners. M. J. Lovett, W. M. Price, and associates of Randsburg.

Production History. This mine had a sporadic production from 1915 to 1918. It is now idle.

General Geology. The ore mined is scheelite. It is found in narrow stringers varying from 2 to 6 inches in width, and occurs in a belt of limestone. The gangue is quartz and calcite. Another strong vein of calcite can be traced for over 1,000 feet along a limestone-schist contact. The vein is about 6 inches in width.

Mine and Plant. A 35-foot shaft has been sunk on a stringer. Several small ditches have also been made. The ore was milled at the Ratcliffe mill.

Bibliography. California State Division of Mines 13, no. 153; Tucker, W. B. 21, p. 316; 29, p. 63.

Madera County

Beasore Group

Location. Sec. 36, T. 3 S., R. 22 E., M.D. Several claims are located in the upper Iron Creek Basin, Madera County.

Owner. The claims were formerly owned by Tom Beasore of North Fork, California, but are now owned by the Minaret Consolidated Mines Company.

Production History.[8] The mineral is reported to be hübnerite, of which several tons were packed out about 1917; but there is no record of production since. It is now idle.

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[8] Supplied by Walter W. Bradley, April 15, 1941.

General Geology. Tungsten occurs in veins, which are opened by a short drift.

Bibliography. Erwin, H. D. 34.

I. X. L. Claim

Location. This claim is located in the foothills of the Sierra Nevada, about 12 miles north of Raymond, Madera County.

Production History. This claim was originally located for a copper property; in neighboring claims, copper was mined in 1907. The ruins of an old copper smelter, which evidently treated the oxidized copper ores, are present. In 1928 the deposit was as yet undeveloped, although about 200 or 300 pounds of wolframite are said to have been taken out.

General Geology. The wolframite occurs as masses and large crystals in a quartz vein. The country rock is an andalusite-mica schist in which the andalusite is considerably crushed and altered. There are numerous large parallel, and nearly vertical, quartz veins in the vicinity. These cut the inclined schists which are heavily stained with copper minerals. The tungsten-bearing vein, however, shows no signs of copper staining. This vein is from 4 to 16 inches wide, and is primarily glassy quartz. The vein pinches out at a depth of 40 feet; but as it follows an evident fault, it could probably be picked up at depth. The wolframite occurs in bunches up to 3 or 4 pounds in weight, and in large crystals. Pyrite occurs as an accessory mineral.

Bibliography. Eakle, A. S. 14, p. 176; 23, p. 271; Hess, F. L. 08; Laizure, C. McK. 28, p. 344; McLaughlin and Bradley 16, p. 568.

Silver Horde Mine

Location. This deposit is located near the Silver Horde mine in the North Fork mining district, just north of Minarets, Madera County. The mine is at an elevation of 8,500 feet, but is easily accessible.

Production History. No production from this deposit has been reported.

General Geology. Tungsten, in the form of wolframite, occurs near the silver, lead, gold, and copper deposit of the Silver Horde Mine. The deposit occurs in a metamorphic area of slate and volcanics.

Bibliography. Tucker, W. B. 21, pp. 305-306.

Mono County

Black Rock Tungsten Mine

Location. Sec. 14, T. 3 S., R. 31 E., M.D. This property is located about 8 miles south of Benton, and 3 miles southwest of Yellowjacket Spring. The mine is readily accessible by a good road from Benton.

Owner. Tungsten Corporation of America, 811 West 7th Street, Los Angeles.

Production History. There was a reported production from this mine from 1927 to 1930. There are no figures available, however, as to the tonnage produced. Again in 1939, there was a reported production. The mine was operating in June 1940.

General Geology. The deposits mined are of the contact-metamorphic type. A mass of limestone and tactite forms the core of a north-plunging asymmetric anticline which has been intruded on the west limb by granite. At the surface the granite is in contact with schist, but at depth the granite cuts the limestone and tactite beds. The outcrop of the limestone-tactite zone is about 1,200 feet long. There has been a large amount of faulting in the fold. An altered rhyolite dike and several diabase dikes cut the orebody. Scheelite is the ore mineral. Garnet, amphibole, diopside, calcite, epidote, quartz, sulphides, and chlorite are the remaining constituents of the tactite. The scheelite is disseminated through the ore; and though some large crystals are found, the greater part of the scheelite is microscopic in size. The ore averages about 0.5 percent WO_3.

Mine and Plant. The mine is developed by four adits and a glory hole from which much of the ore has been taken. There is also one other glory hole which is in the footwall of the ore. There is no more than 10,000 tons of proven ore developed.

Bibliography. California State Division of Mines 13, no. 35; Hess and Larsen 22, pp. 276-277; Lemmon, D. M. 40b, pp. 587-590.

Nevada County*

Empire and North Star Mines

Location. T. 16 N., R. 8 E., M.D. These mines are in the Grass Valley district, Nevada County.

Owner. Empire-Star Mines Company.

Production History. These mines have had a huge gold production, but no tungsten has been produced.

General Geology. Scheelite occurs in minor amounts in the quartz gangue of the gold ores in both the Empire and Pennsylvania veins. It is sparingly and spasmodically disseminated through the veins from surface to deepest levels; but there is apparently no ore of commercial grade, so far as the scheelite is concerned.

Bibliography. Boalich and Castello 18, p. 12; Eakle, A. S. 14, p. 176. Nobs, F. W., unpublished note on 1917 mineral production questionnaire.

Union Hill Mine

Location. Secs. 25, 26, T. 16 N., R. 8 E., M.D., a few miles southeast of Grass Valley, about a quarter of a mile from the Nevada County Narrow-Gauge Railroad.

Owner. Idaho-Maryland Mines Corporation, San Francisco.

Production History. Scheelite concentrates were produced in 1915, 1916, and 1917. Gold was the main product, and scheelite was recovered only during the boom years of the World War. The mine has not now a separate existence, but the vein is being worked for its gold ores through the New Brunswick shaft of the Idaho-Maryland group, which adjoins the property on the east.

General Geology. The scheelite occurred in a quartz vein associated with pyrite, free gold, and minor amounts of galena, and sphalerite. The vein is a fissure type in dark-green, altered volcanic rock, locally known as porphyrite. The deposit is generally considered to be of high-temperature origin. The scheelite is massive and occurs along fissures developed in the quartz. It is therefore later than the quartz gangue of the vein.

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* See also, page 224.

Mine and Plant. The mine was developed through a shaft to a depth of 1,200 feet. The New Brunswick mine has cross-cut to the vein on their 1,300-foot level, and is working the vein below that level at the present time. The mill consisted of a 5-stamp mill. The ore was roasted to change the pyrite to a soft brown iron oxide, and the scheelite was then separated on Wilfley tables.

Bibliography. Boalich and Castello 18, p. 13; California State Division of Mines 13, no. 31; no. 211; Fink, C. G. 16, p. 688; Hess, F. L. 21, p. 938; McDonald, P. B. 16.

San Bernardino County

Four Brothers Mine

Location. Sec. 3, T. 6 N., R. 4 W., S.B. This mine is located 3½ miles east of the Mojave River in the Oro Grande Range, northeast of Victorville, San Bernardino County.

Owner. (1916) Joseph Scheerer et al., of Victorville.

Production History. This mine was a gold producer, and no tungsten production was ever reported. In 1916, three claims on the south side were being developed for tungsten. The property is now idle.

General Geology. The country rock is diorite, which is intrusive into limestone. The contact is several miles to the south. Quartz veins cut the granite and have been reported to carry small amounts of tungsten. The limestone is coarsely crystalline and nearly pure. No contact-metamorphic zone has been discovered. It is highly improbable that any large tungsten deposits will be found in the district.

Bibliography. Cloudman, Merrill, and Huguenin 19, pp. 815, 849.

Guadalupe Tungsten Mine

Location. This mine is located about 4 miles from the town of Manvel, San Bernardino County.

Production History. No production has been made from this mine, although the ore has been reported to carry 60 percent WO_3.

Bibliography. Forstner, Hopkins, Naramore, and Eddy 06, p. 355.

Shadow Mountain Deposits

Location. The Shadow Mountains are located about 20 miles northwest of Adelanto, in the Mojave Desert. Tungsten claims have been located on the southern, western, and northern slopes of these mountains. A good road connects the deposits on the northern slope with the main highway from Adelanto to Kramer Junction. The other deposits are also accessible by road.

Ownership. The deposits on the northern slope are owned by Shadow Mountain Tungsten, Incorporated; Just Associates, 715 Commercial Exchange Building, Los Angeles, California. Nicholas Baxter, of San Bernardino, and the McKee Brothers, (who also own claims near Havilah) are the owners of claims on the southern slopes.

Production History. A small production has been reported from these deposits, but no figures as to the amount produced are available.

General Geology. The Shadow Mountains are composed largely of a dark biotite granite, which is intruded into a series of sedimentary limestones. The limestone is altered to a light-colored garnet-epidote-calcite marble. There is a minor amount of scheelite present in the ore. The ore is reported to average from 0.5 to 1 percent WO_3.

Mine and Plant. The deposit of the Shadow Mountain Tungsten Company has been extensively trenched and sampled. A mill was erected, but it proved unprofitable and was consequently torn down. The deposit is now idle. The operators in this region are handicapped by a lack of water.

United Tungsten Copper Mines

Location. T. 2 N., R. 3 E., S. B. The 30 unpatented claims are located in the old Morongo district on the eastern slope of the San Bernardino Mountains, near the top of the range. They are about 50 miles southeast of Victorville, and are accessible by road.

Owner. United Tungsten Copper Mines Corporation, 30 Broad Street, New York City.

Production History. The mine produced tungsten from 1916 to 1918, but the amount is not reported. The property is now idle.

General Geology. The orebody is a scheelite-bearing contact-metamorphic deposit. The country rock is a fine-grained biotite granodiorite intruded into a previously marbleized limestone. In places both the granodiorite and the limestone are highly altered. The limestone beds are in no places more than 10 feet in thickness, and the known orebodies are very small. The minerals of the altered limestone are quartz, a gray mica, epidote, garnet, actinolite, clinozoisite, calcite with accessory apatite, titanite, pyrite, a bismuth mineral, and scheelite. The richest ore appears in soft brown rock masses which are highly oxidized and in which the minerals are difficult to determine. The scheelite is generally coarsely crystalline and often occurs in the quartz.

Bibliography. Boalich and Castello 18, p. 14; California State Division of Mines 13, no. 183; Hess and Larsen 22, p. 261; Tucker, W. B. 21, p. 374; Tucker and Sampson 30, p. 295.

San Diego County

Gold Standard Group

Location. Sec. 12, T. 15 S., R. 4 E., S. B. This deposit is in the Deer Park district, near Descanso, San Diego County.

Production History. A small amount of scheelite was produced in 1925. The property is now idle.

General Geology. The ore occurs as scheelite in gold-quartz veins.

Bibliography. Tucker, W. B. 25, p. 353.

Oak Grove Tungsten Mine

Location. Sec. 16, T. 9 S., R. 2 E., S. B. This mine is located in the Aguanga Mountains, near Oak Grove Valley, San Diego County. Several claims have been located in Secs. 30, 31, T. 8 S., R. 3 E., and in Secs. 6, 7, T. 9 S., R. 3 E., S. B.

Owners. Bert Simmons and J. Wentworth, of Aguanga.

Production History. This mine had a small production in 1917; it is now idle.

General Geology. These deposits are of the contact-metamorphic type. Several bodies of metamorphosed limestones have been found in a fine-grained granite. Some are small—only a few feet across and of short length—others are as much as 40 feet across and 200 feet long. The smaller bodies generally carry lime-silicate minerals and scheelite throughout. The larger bodies have irregular cores of marble.

The dark-silicate or tactite zone is composed of quartz, brown garnet, calcite, epidote, amphibole, and a little scheelite. The light-colored silicate zone is made up of wollastonite, colorless garnet, diopside, calcite, titanite, and quartz. Quartz-actinolite rock is present and carries scheelite. The deposit has been prospected only slightly, and is not very well exposed.

Bibliography. California State Division of Mines 13, no. 55; no. 155; Hess and Larsen 22, p. 260.

Shasta County[9]

It was reported (1917) that gold quartz veins carrying scheelite occur in the vicinity of T. 37 or 38 N., R. 3 W., M. D., a 30-mile pack trip from a road. There is no record of development or production.

Tulare County

Anita May Claim

Location. Sec. 36, T. 24 S., R. 31 E., M. D. This property is located just below the Kennedy Tungsten Mine, 2 miles southeast of Jack Ranch. About 140 feet of tunnel have been driven. The ore is scheelite in a garnetiferous gangue. The country rock is granite, schist, and blue limestone.

Bibliography. Franke, H. A. 30, p. 465.

Jack Ranch Mine

(See Tungstore mine.)

Tungstore Mine

Location. The Tungstore mine is situated on the Berry Ranch, 2 miles south of Jack's Ranch, in T. 25 S., R. 31 E., M.D., 3 miles southeast of Posey and 9 miles northeast of Glennville.

Owner. Tungstore Mines Co.; W. A. Trout, president; C. A. Rasmussen, secretary, 929 American Avenue, Long Beach, California; Ivar Helfer, superintendent.

Production History. The property has been a producer of tungsten concentrates since 1931. Twelve men are employed.

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[9] Note supplied by Walter W. Bradley, April 15, 1941.

General Geology. The deposit is contact-metamorphic. The ore occurs in a tactite zone, with a limestone footwall and a granite hanging wall. The mineralized zone strikes east and dips 45° south. Its width ranges from 15 to 20 feet, averaging 20 feet; the WO_3 content varies from 0.5 percent to 2.0 percent. The outcrop is exposed on the surface for a distance of 300 feet.

Mine and Plant. Ore is mined from a glory hole, the floor of the glory hole being 50 feet below the outcrop. There is a tunnel 400 feet in length, with two raises 125 feet apart.

Ore from the mine is trammed in cars to the coarse-ore bin (capacity 50 tons) ; from the bin to a No. 6 Wheeling crusher; then to a 1-inch grizzly. Material over 1-inch size is sent to a No. 6 Wheeling crusher, the product from the second Wheeling crusher being sent to 26-inch rolls. The product from the rolls goes to the ore pocket; it is then elevated by bucket elevator to an impact screen. It is screened to 14 mesh, the oversize being returned to the rolls, the minus 14 mesh going to the fine-ore bin (capacity 50 tons). The ore from the fine-ore bin goes to a vibrating screen; the through-product going to two Overstrom tables. The plus 14 mesh material goes to a Herman ball-mill. The plant has a capacity of 40 tons per 24 hours. Power for crushing and concentration plant is developed by an 80-horsepower Diesel engine. Concentrates are dried, then cleaned with Dings magnetic separator. Concentrate produced is reported to carry 70 percent WO_3.

Verne Tyler Mine

Location. This tungsten mine is located 3 miles east of California Hot Springs, Tulare County.

Ownership. The property is owned by Verne Tyler, but has been leased by David Bushness and Blake Wilson of Los Angeles on a royalty basis.

Production History. Ten tons are being handled daily, and a recovery of 800 to 1,000 pounds of ''tungsten'' has been reported. Modern machinery is being used and it is planned to install a light plant to allow for night work.

Bibliography. Mining Journal, The 41.

Tuolumne County[10]

A small amount of scheelite has been found on the Mackey Ranch, 3 miles from Jamestown (Pabst, A. 38). There is no record of production.

CONCLUSION

From this study of the tungsten resources of California, it may be concluded that there is a large supply of tungsten in the State, and that production should increase during the coming years. A better knowledge of the geological occurrences of tungsten, and increased prospecting work by trained men, will undoubtedly result in the discovery of new deposits of commercial size. The area around Kernville and the Greenhorn Mountains seems to be a particularly favorable locality for the discovery of commercial orebodies. The Atolia and

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[10] Note supplied by Walter W. Bradley, April 15, 1941.

Bishop districts are in no way mined out, and a planned prospecting program in these areas will probably uncover new orebodies.

This report has also shown that there are several problems which face the tungsten industry, which warrant special study.

One problem is that of encouraging tungsten mining in times of war, so that this country can be self-sufficient and supply all demands for tungsten ores and concentrates. The Government stimulation and encouragement as adopted during the last war, while successful in maintaining an adequate supply during the war, was found to have serious difficulties after the war period. In order to aid the operators who suffered losses as a result of this Government stimulation, the War Minerals Relief program was adopted. This, while it offered relief in many cases, also brought about endless litigation over allowed and disallowed claims. A study of this problem of industry stimulation and its aftermaths is of particular importance at the present time, when all foreign sources of strategic minerals are in danger of being cut off and the United States may again find it necessary to supply all of its domestic needs.

Another problem which is perplexing the tungsten industry in particular is that of much-needed improvements in the technology of treating the ores. The large losses of tungsten in the tailings, due to sliming during milling, have been pointed out in the chapter on metallurgy. The study of this problem requires experimentation in the laboratory on various ore-dressing methods. Improved flotation methods seem to offer the best solution of this problem; but other possibilities are also being pursued, such as centrifugal separation due to difference in specific gravity, and leaching of impurities from the ore and concentrates.

Still another study, not so important as the two above-mentioned, but still of practical value, is that of developing a method for carrying on a systematic prospecting program with the aid of the ultra-violet light and its fluorescent effect on scheelite. The fluorescence of scheelite shows up remarkably well in photographs of rock specimens. It has been suggested that the mining face be photographed under ultraviolet light, and that the scheelite areas which show up on the finished print be measured by planimeter for the area. The ratio of the scheelite area to the area of the face would be a measure of the value of the ore. Difficulties arise in that scheelite is often found in paper-thin plates of large surface area, as at Atolia. In such instances too high a valuation of the ore would result. This could be overcome by the development of correction factors for each different deposit. The wet chemical methods of assay for tungsten are long and expensive, and a simple, rapid method of this sort would be of great value in mining operations. The use of the ultra-violet light in prospecting has already been developed to a considerable degree, and its value as an ore-finding aid proven (Vanderburg, W. O. 36); but thus far its use has been restricted to showing the presence of scheelite in the rock in a qualitative, not quantitative, manner.

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SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

DRAGLINE DREDGING IN SISKIYOU COUNTY

By Chas. V. Averill, Mining Engineer

Dredging in the counties of Shasta, Siskiyou, and Trinity was described in State Mineralogist's Report XXXIV[1] for 1938, and in that article many details were given on methods used in dragline dredging, also details of construction of the washing plant. The present article does not attempt to cover all of the dragline dredges in Siskiyou County, but only two later installations which have certain special features.

Scandia mine, in secs. 7, 8, 9, 15, T. 46 N., R. 10 W., on Horse Creek near the Klamath River, was being operated in 1940 by Larsen Bros. and Harms Bros., Rt. 4, Box 2220, Sacramento. Emmet Miles, Horse Creek, Siskiyou County, was in charge at the mine. The property is reached by means of two miles of dirt road turning from the graveled state highway along the Klamath River.

Low bars of Horse Creek for a total length along the creek of 6 miles were being dredged. The width was about 1,000 ft. in the lower part of the tract but less above. Depth of gravel was 12 ft. to 18 ft. and practically all the gold was in the lowest 2 ft. From a tract of 100 acres about 2,000,000 cu. yds. had already been dredged in the fall of 1940.

The washing plant is of Bodinson make and is similar in all respects to the ones described in the reference already given. It is of 3,600 bank-yards capacity per 24 hrs. and is built to serve a 3-cu. yd. dragline excavator. The bucket in use is a 2¼-yd. Esco. The trommel is punched with ⅜-in. to ¾-in. holes, and undersize goes to standard-dredge-type Hungarian riffles. Murphy 6-cylinder diesel engines rated at 160 hp. each supply the power on both the excavator and the washing plant.

The following figures on cost of equipment and cost of operation were furnished by Emmet Miles: 95 Northwest dragline with 60-ft. boom, $58,000; washing plant, $40,000; D7 tractor with bulldozer, $7,000; D8 tractor with carryall, $10,000; truck, welder, pickup, $1,900; miscellaneous lighting plants and pumps, $1,000; air compressor, $200; spare generator for washing plant, $900. The last item mentioned furnishes power to an electric motor on the upper end of the belt stacker. The total crew comprises 14 men.

Gravel actually washed on boat cost 5¢ to 6¢ per cu. yd. to handle. Cost of removing and leveling overburden was 7¢ per cu. yd. No depreciation was included in these costs. To cover the cost of mining, stripping overburden and leveling, including depreciation but excluding profit, it was necessary for the gravel to run 10¢ per cu. yd.

Restoration of the land in order to make it available for farming appears to be an acomplished fact at this mine. A tract of 100 acres is being so restored, and 60 acres were to be planted to new crops, alfalfa, rye and sweet clover in the fall of 1940. Some of the fields were already green with the new crops in October, 1940.

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[1] Averill, C. V., Gold Dredging in Shasta, Siskiyou and Trinity Counties: California Journal Mines and Geology, April 1938.

The land along the creek averages 1,000 ft. in width. It carries an overburden of soil five to six feet in depth. For dredging, it is divided into strips roughly 300 feet in width. From the first strip the soil overburden is removed to wasteland along the outside of the tract. This is done with a D8 Caterpillar tractor and a carryall of 12 cubic yards capacity. At times a second outfit of 16 cubic yards capacity has been in use. After the soil has been removed from the 300-foot strip, the gravel beneath is dredged with the dragline to a depth of 12 to 18 feet. The belt-stacker on the dredge leaves the gravel behind in conical piles about 20 feet high. Next a Caterpillar tractor with bulldozer attachment levels these piles, and the running back and forth of the heavy machine packs the gravel considerably. Then the soil of the second 300-foot strip is removed by the carryalls and placed on the leveled gravel of the first strip, and is spread out and graded so that the land is ready for farming. The process is continued to the last strip, where the gravel is spread in the form of a dike to hold the stream in a prepared channel. Previously the stream ran near the center of the tract and gave trouble from flooding and washing the land. Hence, the operators believe that the land is left in better condition for farming than it was originally.

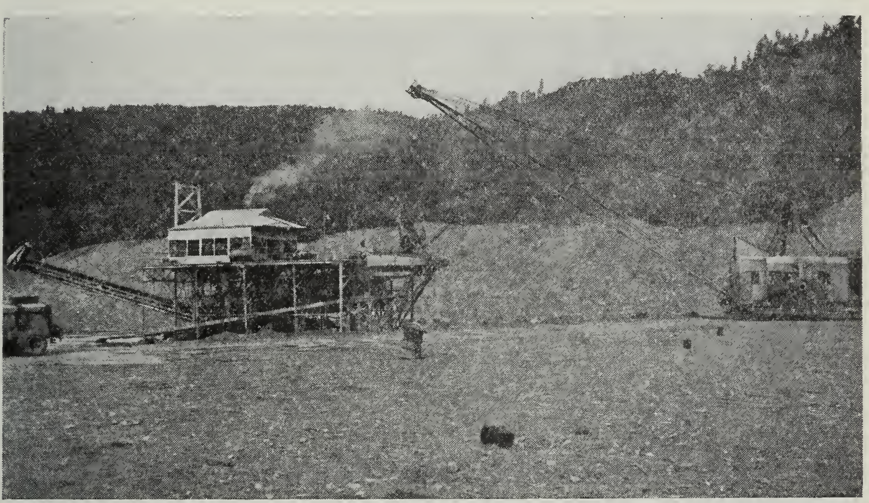

FIG. 1. Moccasin Mine, dragline and washing plant, on Klamath River, Siskiyou County.

Efforts have been made in the past to level the gravel from a dredge and to throw out the fines directly from the dredge on top of the gravel. Disturbing of the gravel by the dredge results in an increase of voids between the various boulders and cobbles, and the fines go into these voids to a great extent. Even if soil is left on top, it may gradually sink to fill the voids, leaving gravel and boulders exposed on the surface. The present method overcomes the difficulty in two ways: the heavy machines pack the gravel, and the five to six feet of soil put on top gives a wide margin of safety.

Unfortunately this method can not apply to all dredging-land. First, the average tract does not contain such a thick layer of good soil. Second, the method is expensive, and the average tract does not contain enough gold to pay for it. The operators figure that the extra cost of restoring the land was $20,000 for a tract that is worth less than $10,000 as a farm. As an example of the expense involved, consider the fact that one tractor worth about $8,000 had already been worn out in roughly a year and a half, and in the fall of 1940 a second was well on the way to being worn out.

However, the land along Horse Creek contained enough gold to pay for the restoration and a profit besides. The original restored tract was used to induce the owner of an adjoining tract to allow his land to be worked by the same method, so the whole operation is profitable.

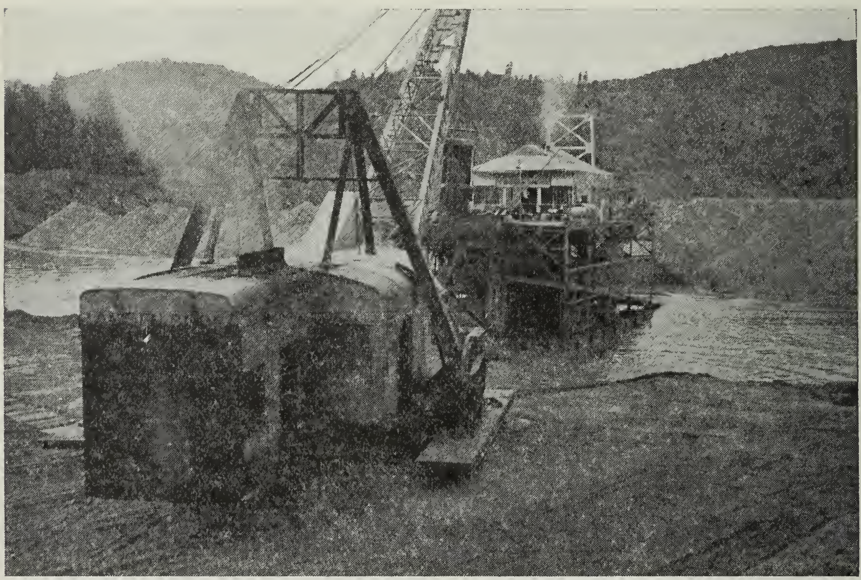

FIG. 2. Moccasin Mine, 5-cu. yd. Monighan dragline, on Klamath River, Siskiyou County.

Moccasin mine, in sec. 14, T. 46 N., R. 10 W., was also operated by Larsen Bros. and Harms Bros., Rt. 4, Box 2220, Sacramento, in 1940. The property is on the Klamath River about 1½ miles up the river from Horse Creek. It is reached from the bridge at Horse Creek by means of a road up the north bank of the river. A river bar about 2,000 ft. wide carrying gravel to a depth of 18 ft. to 35 ft. was being dredged. Total depth in some places including 10 ft. of fine overburden was 45 ft.

The Moccasin outfit includes the largest dragline excavator used for dredging in northern California. The only larger dragline used for any purpose is the one that excavates gravel from the Sacramento River at Redding for aggregate to build Shasta Dam. The 5-yd. Monighan at Moccasin mine walks around much as a man walks and is equipped with a large foot on each side for that purpose instead of the Caterpillar treads commonly used on smaller draglines. It has a

100-ft. boom and is capable of digging to a depth of 45 ft. The bucket in use is a 4½-cu. yd. heavy-duty Esco.

The washing plant is of Bodinson make and has a capacity of 6,000 cu. yds. per 24 hrs. The trommel is 47 ft. by 72 in. and the largest holes are ¾ in. AR (abrasion resistant) steel used on the first section of the trommel had given 7½ months of service in the fall of 1940. The pump is a 14-in. United Iron Works pump driven by 100 hp. General Electric motor. The 85-ft. stacker carries a 42-in. belt. The barge is 40 ft. by 64 ft. by 54 in. deep. Power is furnished by a 300-hp. Fairbanks Morse diesel engine on each machine, the dragline and the washing plant. The engine on the washing plant drives a 200-kva. Fairbanks Morse alternator, 480 volts. Boil-boxes similar to those used by Lincoln Gold Dredging Co. in Trinity County are used under the trommel. A manifold supplies jets with water under pressure in the various compartments beneath the trommel and thus the sands are kept in agitation.

The overburden, 10 ft. in depth, is removed and piled to one side by means of a D8 Caterpillar tractor and a 12-cu. yd. carryall. No attempt is made at resoiling as at the Moccasin mine. The river was to be turned into a channel prepared for it on the north side of the tract during the winter, 1940–41, so that the present channel of the Klamath River could be mined. Near the river the gravel is free of overburden and is 18 ft. in depth. The width of the pond being carried in 1940 was 500 ft.

Costs of principal items of equipment set up on the job were furnished by R. H. Wallace, Superintendent, as follows: Monighan, $75,000; washing plant, $70,000; D8 tractor and carryall, $16,000. The total cost of operating the equipment per cu. yd. of gravel was stated to be 9¢.

MARKETING TALC, PYROPHYLLITE, AND GROUND SOAPSTONE[1]

By Bertrand L. Johnson[2]

DEFINITIONS

Pure talc is a hydrous magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$). Pyrophyllite, although it resembles talc in certain physical properties and uses, is a hydrous aluminum silicate ($Al_2Si_4O_{10}(OH)_2$)—like kaolin, except that kaolin has a somewhat different composition ($Al_2Si_2O_5(OH)_4$) and structure. Soapstone can be considered essentially an impure talc and when pulverized is used for many of the same purposes as talc. Massive, compact varieties of talc often are called steatite.

PROPERTIES

Talc and pyrophyllite are characterized by their softness (hardness on Mohs' scale, 1), their greasy feel, pearly luster, white color, and perfect basal cleavage. They have similar crystal structures, and this similarity explains the close resemblance of the two minerals in physical and chemical properties. Talc is a good electrical insulator, resists the action of most acids and alkalies, and has an exceptional heat-retaining capacity. Its specific gravity is about 2.7.

Most commercial talcs are not pure but are mixtures of talc with other minerals occurring in the talc deposits and usually left in the product. Accessory minerals include dolomite, calcite, magnesite, serpentine, and tremolite with occasional chromite, magnetite, and also traces of nickel and other constituents of basic igneous rocks. Talcs produced in different localities differ in mineral contents and in physical as well as chemical properties. Some differences may exist in talcs from different parts of the same deposit.

Commercial talcs are classified as 'hard' and 'soft', 'fibrous' and 'flake', as well as according to screen size and color. 'Fibrous' talc owes its structure mainly to needlelike tremolite and gritty talcs to grains of dolomite or magnesite. Dark talcs are likely to contain admixed serpentine or chlorite. Flake and soft talcs only are relatively pure.

OCCURRENCE

Commercial deposits of talc are found in much-altered ultrabasic intrusions and in metamorphosed limestones. In the United States they occur in the pre-Cambrian limestones of the Adirondacks, in the ancient metamorphosed sediments and ultrabasic intrusives of the Piedmont Plateau, and in the much folded and metamorphosed mountainous belt of the Pacific coast. The only commercial pyrophyllite deposits in the United States are hydrothermal metasomatic replacements of dacitic and rhyolitic volcanic rocks in central North Carolina.

USES

Except in the ceramic industry most of the uses of talc, pyrophyllite, and ground soapstone depend on physical rather than chemical properties, and the minerals are not subject in their utilization to temperatures high enough to decompose them and initiate chemical changes.

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[1] Reprinted from U. S. Bureau of Mines Information Circular No. 7080.

[2] Associate mineral economist, Nonmetal Economics Division, Bureau of Mines.

Talc serves the paint industry principally as an extender, although in some paints it is the principal pigment. The fibrous talc (asbestine), a mixture of tremolite fibers and talc, is used largely in cold-water paint, the fibers of tremolite bonding the paint film. Flake talc and pyrophyllite are also incorporated in paints.

White, fine-grained talcs are used for loading the better grades of paper. The low-priced, off-color, low-grade talcs and pyrophyllite are used to form an inert, fireproof, weather-resisting coating for roofing papers.

Talc and pyrophyllite enter the ceramic industry in considerable quantities. Calcined talc ('lava') meets the special requirements of the electrical and refractory industries, being sold either as calcined sawed and machined block material or compounded from talc and silicate of soda, and then pressed into blocks and calcined. An important use of talc in the ceramic industry is in the preparation of sagger bodies. Considerable quantities of talc are sold to wall-tile and white-ware manufacturers, who also utilize pyrophyllite.

Various industries needing fillers utilize talc, pyrophyllite, and ground soapstone. Rubber manufacturers are said to take the largest amounts for use either as a filler or as a lubricant. Smaller quantities are used by the makers of asbestos goods, floorings, wall plasters, insecticides, ropes, and plastics.

The lubricating properties of talc, pyrophyllite, and ground soapstone are utilized in many industries. Manufacturers of cup greases, foundry castings, rubber tires, bottles, and candy and users of box-nailing machinery and dies of various kinds consume small quantities.

Talc is the principal base in various toilet preparations, but this use is very small compared with total talc consumption. Some pyrophyllite has been used. Fine, pure-white material is required for this use.

Talc is used for abrasive or polishing purposes where the material to be polished is soft, such as peanuts or coffee beans, or where the dirt is to be removed from a soft underlying material, such as marble or lacquer.

PRODUCTION

The annual world production of over four hundred thousand tons of talc, pyrophyllite, and ground soapstone comes from many countries, principally, however, from highly industrialized ones. Nonindustrial countries produce only high-grade talc in small quantities for a limited market.

In the United States, Canada, and Germany, many uses have been found for the lower grades. In France and Italy the chief product is high-grade talc for toilet use and massive talc for 'lava' manufacture, but some use is made of the lower grades. In most of the other producing countries there is little or no market for anything but the highest grades. Thus, India, Brazil, Japan, and Spain have produced only small quantities.

The United States has for many years been the outstanding source of these materials, producing in recent years over one-third of the world total and two to three times as much as any other country. France, China (including Manchuria), Italy, Norway, and Austria usually followed in the order given.

The United States produces most of its requirements in talc. This production comes from the eastern belt along the Atlantic coast from Vermont to Georgia, and from the Pacific Coast States of California and Washington. The eastern belt is by far the largest producing region, with New York the leading producing State. Production of pyrophyllite is confined to North Carolina.

Although there are usually 30 to 40 producers of talc, pyrophyllite, and ground soapstone in the United States in a given year, over half of the domestic production comes from not more than half a dozen concerns.

SALES

In the 3½ decades from 1880 to the World War, the total sales of talc, pyrophyllite, and ground soapstone rose from a few thousand tons a year in the early eighties to annual sales of nearly 200,000 tons. In the two decades since the World War, however, sales of these commodities have risen a little above the 200,000-ton level, but only on the crests of booms—in 1920, 1928 and 1929, and in 1936, 1937, and 1938. Increased use of talc in the ceramic industry during the last boom period carried the sales in 1937 to a new all-time record height of 229,999 short tons.

Prior to the recent depression the bulk of these materials came from New York and Vermont, but since 1932 increasing quantities have come from California and North Carolina. New York is still the leading producing state. North Carolina has furnished all the pyrophyllite. The following table shows the sales of domestically produced talc, pyrophyllite, and ground soapstone, by classes, for the past 11 years (1928-38), covering the cycle from the crest of the 1929 boom to that of 1937.

SALES OF DOMESTIC TALC, PYROPHYLLITE, AND GROUND SOAPSTONE, 1928-1938 BY CLASSES

Year	Crude		Sawed and manufactured		Ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1928	6,360	$48,031	936	$70,394	195,680	$2,419,569	202,976	$2,537,994
1929	11,228	87,820	473	140,928	208,082	2,399,914	219,783	2,628,662
1930	4,972	48,913	385	90,370	174,028	1,969,055	179,385	2,108,338
1931	6,673	47,382	181	51,740	156,898	1,753,350	163,752	1,852,472
1932	5,635	51,657	107	17,749	117,479	1,292,227	123,221	1,361,633
1933	5,985	46,553	246	31,686	159,792	1,653,643	166,023	1,731,882
1934	8,767	55,659	174	46,918	129,564	1,346,108	138,505	1,448,685
1935	10,725	57,259	841	63,211	161,150	1,727,585	172,716	1,848,055
1936	10,910	59,556	618	90,542	204,663	2,193,073	216,191	2,343,171
1937	11,087	52,750	1,101	111,680	217,811	2,397,323	229,999	2,561,753
1938	13,498	72,845	1,729	70,268	197,548	2,159,447	212,775	2,302,560

Only a few thousand tons of domestic crude talc a year (3,956 to 8,878 short tons in recent years) goes to foreign markets, but there is an export trade in talcum powders valued at half a million to a million dollars a year.

MARKETS

The domesic market for talc, pyrophyllite, and ground soapstone is the largest in the world. It not only consumes most of the large domestic production of the crude materials but also imports some hundreds of tons annually. In 1933, a depression year, the domestic industries absorbed 162,315 short tons of talc, pyrophyllite, and ground soapstone, principally of domestic origin, and in 1937, during the following boom, they took 221,445 tons.

This material is distributed as (1) crude talc, (2) sawed or manufactured talc, or (3) ground talc. The market takes 98 percent of its consumption in the ground form. Less than 0.50 percent is in the form of sawed and manufactured material. The balance is in the crude state. The following table shows the extent of the demand for each of these types of material in 1937.

DISPOSAL OF CRUDE TALC, PYROPHYLLITE, AND GROUND SOAPSTONE IN DOMESTIC MARKET IN 1937

Classification	*Short tons*
Domestic crude sold	2,209
Domestic crude sold as sawed and manufactured	1,101
Domestic crude sold ground	217,811
Foreign crude imported	324
Total	221,445

The largest markets for industrial-grade talcs are in the States east of the Mississippi River north of Virginia. California talcs of industrial grade are restricted to the western States, high freight rates prohibiting competition in the eastern area.

There are markets for talc, pyrophyllite and ground soapstone in many different industries, principally, however, in the paint, paper, ceramics, rubber and roofing industries, which in 1938 took 77 percent of the total domestic sales. There are smaller outlets in the toilet preparations, fillers, foundry facing, and crayon industries. The electrical and refractory industries take calcined talc.

The following table shows the quantities and relative percentages of talc, pyrophyllite, and ground soapstone sold to the leading consuming industries, as reported by the producing companies.

TALC, PYROPHYLLITE, AND GROUND SOAPSTONE SOLD IN THE UNITED STATES, 1936-1938, BY INDUSTRIES

Industries	1936		1937		1938	
	Short tons	Per cent of total	Short tons	Per cent of total	Short tons	Per cent of total
Paint	56,613	26	59,660	26	53,506	25
Ceramics	19,073	9	29,793	13	29,590	14
Paper	30,996	14	32,127	14	27,329	13
Roofing	25,160	12	23,551	10	27,607	13
Rubber	27,076	13	26,941	12	25,374	12
Toilet preparations	4,293	2	4,340	2	5,970	3
Foundry facings	2,781	1	3,228	1	2,511	1
Other	25,091	12	28,265	12	20,732	10
Not reported	25,108	11	22,094	10	20,156	9
Totals	216,191	100	229,999	100	212,775	100

The markets for talc, pyrophyllite, and ground soapstone are shifting. For many years the paint, paper, rubber, and roll-roofing industries, in about the order named, were the principal consumers. In 1938, the ceramic industry, which formerly took a negligible quantity of those materials, took 14 per cent of the total and ranked second. The paint industry now comprises only about a quarter of the total market instead of one-half as formerly. The increased ceramic demand is due to the greater use of talc as a constituent of glazed wall-tile bodies.

Most ground talc is sold today on the basis of grain shape and size, and color. Talcs are graded in sizes ranging from 20 to 325 mesh; in flake or fibrous shapes; and from white to dark in color. Only a few industries require talc in carload lots; the remainder are satisfied with from a few pounds to 4 or 5 tons a year.

PRICES

Talc is a relatively low-priced commodity. The average value per ton of all grades of talc, pyrophyllite, and ground soapstone, f. o. b. mills, in the last 10 years has ranged between $10.43 and $12.50 a short ton, dropping from the latter figure in 1928 to the former in 1933 and rising to $11.14 a ton in 1937. Talcs suitable for manufacturing into blanks for insulators and gas burner tips ('lava-grade' talc) and for making crayons and pencils command the highest prices. High-grade 'lava talc,' lumps, may sell for as much as 6 cents a pound, and the various forms of sawed talc are said to sell generally for at least $100 to $150 a ton, but some of these materials are reported at times to have sold as high as $800 a ton.

Prices on other kinds of domestic talc, pyrophyllite, and ground soapstone are generally much lower. Virginia crude is quoted at $4 a ton. Domestic ground talcs, except toilet grade, normally range in price between $4 and $20 a ton, according to quality and fineness. Much domestic roofing talc, 20 to 50 mesh, is said to have been sold as low as $4 a ton f. o. b. mill. Quotations on finer-ground domestic talcs, f. o. b. works, carload lots, are about as follows in 1939:

Virginia talc, 200 mesh	$4.75– $5.50
Virginia talc, 325 mesh	6.25– 7.00
Georgia talc, 200 mesh	6.00
Georgia talc, 300 mesh	7.50– 10.00
Vermont talc, 200 mesh	8.00– 14.00
New York talc, 325 mesh	11.00– 17.00
California talc	17.00– 20.00

Ground soapstone is generally quoted around $5 a ton for 200 mesh and up to $7 a ton for 325 mesh f. o. b. Virginia plant. Vermont soapstone quotations f. o. b. plant are about $10 to $12 a ton.

Ground pyrophyllite quotations range from $7.50 a ton in carload lots for some grades 200 mesh to $12 a ton for standard grade 325 mesh.

Imported talcs range from $20 (or less) to as much as $85 a ton, the higher prices being for Italian and French talc. French talc sells in U. S., ex-dock, from $23 to $60, and Italian talc from $60 to $85. Manchurian talc sells in the United States for $30 to $40 a ton, a little off-color material selling as low as $20.

Current price quotations of talc, pyrophyllite, and ground soapstone are carried in the following trade journals:

1. Oil, Paint, and Drug Reporter (weekly)
2. Engineering and Mining Journal (monthly)
3. Chemical Industries (monthly)
4. Chemical and Metallurgical Engineering (monthly)
5. Canadian Chemistry and Process Industries (monthly)

Soapstone quotations are carried in Chemical and Metallurgical Engineering and pyrophyllite quotations in the Oil, Paint, and Drug Reporter. The basis for the quotations and also the prices vary considerably in the different journals.

No current prices on crude (except Virginia crude) or sawed and manufactured talc or pyrophyllite are carried in the trade journals, quotations being obtainable only from producers, manufacturers, or dealers in these materials.

BUYERS OF UNMANUFACTURED TALC, PYROPHYLLITE, AND SOAPSTONE

Lava Grade

California

W. K. Thompson, 1949 N. Vermont Ave., Los Angeles.

Maryland

Maryland Lava Co., Bel Air.

New York

Hammill-Gillespie Inc., 225 Broadway, New York.
International Pulp Co., 41 Park Row, New York.
M. Kirchberger & Co., Inc., 14th Ave. and 37th St., Brooklyn.
Union Talc Co., 147 Nassau St., New York.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York.

Tennessee

American Lava Corporation, 1429 William St., Chattanooga.
D. M. Steward, Chattanooga.

Virginia

F. G. Hoffman, Claremont.

For Grinding

California

Henry Rising & Co., 626 St. Paul Ave., Los Angeles.
W. K. Thompson, 1949 N. Vermont Ave., Los Angeles.
Western Talc Co., 1901 E. Slauson Ave., Los Angeles.

Illinois

Superior Flake Graphite Co., 1531 1st Nat'l. Bank Bldg., Chicago.

Maryland

Clinchfield Sand & Feldspar Co., Hearst Tower Bldg., Baltimore.

New York

Hammill-Gillespie Inc., 225 Broadway, New York.
Innis, Speiden & Co., 117 Liberty St., New York.
R. T. Vanderbilt Co., 230 Park Ave., New York
Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York.

Oregon

Miller-Products Co., Portland.

Virginia

Blue Ridge Talc Co., Henry.

Wisconsin

W. E. Krause, 8136 Milwaukee Ave., Wauwatosa.

BUYERS OF SAWED AND MANUFACTURED TALC, PYROPHYLLITE, AND SOAPSTONE

California

W. K. Thompson, 1949 N. Vermont Ave., Los Angeles.

Illinois

F. E. Schundler Co., Inc., 606 Railroad St., Joliet.

Maryland

Clinchfield Sand & Feldspar Co., Hearst Tower Bldg., Baltimore.

New York

Charles B. Chrystal Co., Inc., 16 Hudson St., New York.
Innis, Speiden & Co., 117 Liberty St., New York.
International Pulp Co., 41 Park Row, New York.
Minerals & Insulation Corporation, 139 Spring St., New York.
Smith Chemical and Color Co., Inc., 55 John St., Brooklyn.
Union Talc Co., 147 Nassau St., New York.
R. T. Vanderbilt Co., 230 Park Ave., New York.
Whittaker, Clark & Daniels Inc., 260 W. Broadway, New York.

North Carolina

Nantahala Talc & Limestone Co., Andrews.

Pennsylvania

Enterprise White Clay Co., 139 S. 3d St., Philadelphia.
Chas. A. Wagner Co., Inc., 811 Callowhill St., Philadelphia.

Tennessee

D. M. Steward Mfg. Co., Chattanooga.

Virginia

F. G. Hoffman, Claremont.

BUYERS OF GROUND TALC, PYROPHYLLITE, AND SOAPSTONE

California

Braun-Knecht-Heimann Co., Ltd., 1400 16th St., San Francisco.
Commercial Minerals Co., 130 Irvin St., San Francisco.
W. K. Thompson, 1949 N. Vermont Ave., Los Angeles.

Georgia

Thompson, Weinmann & Co., Cartersville.

Illinois

Amalgamated Roofing Co., Clearing.
Armour Soap Works, 1355 W. 31st St., Chicago.
The Lehon Co., 4425 S. Oakley Ave., Chicago.

Indiana

National Tile Co., Inc., Anderson.

Maryland

Clinchfield Sand & Feldspar Co., Hearst Tower Bldg., Baltimore.
Maryland Lava Co., Bel Air.
E. M. & F. Waldo Inc., Muirkirk.

Massachusetts

Davidson Rubber Co., 50 Brighton St., Charlestown, Boston.
The Fisk Rubber Corporation, Chicopee Falls.

Missouri

Cupples Co., 7th and Spruce St., St. Louis.

New Jersey

American Oil & Supply Co., Trenton.
Merck & Co., Inc., 1935 Kerrigan Road, Rahway.

New York

H. J. Baker & Bro., 271 Madison Ave., New York.
Certain-teed Products Corp., 101 E. 41st St., New York.
Charles B. Chrystal Co., Inc., 16 Hudson St., New York.
Hammill-Gillespie Inc., 225 Broadway, New York.
Innis, Speiden & Co., 117 Liberty St., New York.
International Pulp Co., 41 Park Row, New York.
Larkin Co., Inc., (J. A. Handy), 680 Seneca St., Buffalo.
Minerals & Insulation Corp., 139 Spring St., New York.
National Mfg. Corporation, Tonawanda.
C. J. Osborne Co., 132 Nassau St., New York.
Smith Chemical & Color Co., Inc., 55 John St., Brooklyn.
L. A. Solomon & Bro., 216 Pearl St., New York.
Special Service Flooring Corporation, 520 Waverly Ave., Mamaroneck.
Union Talc Co., 147 Nassau St., New York.
R. T. Vanderbilt Co., 230 Park Ave., New York.
Whittaker, Clark & Daniels Inc., 260 W. Broadway, New York.
Wishnick Tumpeer Inc., 295 Madison Ave., at 41st St., New York.

Ohio

Philip Carey Mfg. Co., Lockland, Cincinnati.
Harshaw Chemical Co., 1945 E. 97th St., Cleveland.
E. S. Jackson & Co., 224 E. 2d St., Cincinnati.
Weaver Wall Co., Brookpark and State Roads, Cleveland.

Oregon

Miller Products Co., Portland.

Pennsylvania

Chemical & Pigment Co., Scranton.
Enterprise White Clay Co., 139 S. 3d St., Philadelphia.
Hammermill Paper Co., Erie.
Chas. A. Wagner Co., Inc., 811 Callowhill St., Philadelphia.

Tennessee

American Lava Corporation, 1429 William St., Chattanooga.
D. M. Stewart Mfg. Co., Chattanooga.

Virginia

Blue Ridge Talc Co., Inc., Henry.
F. G. Hoffman, Claremont.

Wisconsin

W. E. Krause, 8136 Milwaukee Ave., Wauwatosa.

UNCLASSIFIED REPORTED BUYERS OF TALC, PYROPHYLLITE, OR GROUND SOAPSTONE

California

Blue Star Mines, Ltd., 840 San Julian St., Los Angeles.
Pacific Coast Talc Co., 2149 Bay St., Los Angeles.

Illinois

Brunswick-Balke-Collender Co., 623 S. Wabash Ave., Chicago.
S. Obermayer Co., 2559 W. 18th St., Chicago.
U. S. Gypsum Co., 300 W. Adams St., Chicago.

Maryland

Harford Talc and Quartz Co., Towson.

Massachusetts

Hood Rubber Co., Inc., Watertown.
E. & F. King & Co., Inc., 405 Atlantic Ave., Boston.

Michigan

Paper Makers Chemical Corporation, Kalamazoo.

Missouri

American Asphalt Roof Corporation, 15th and Blue River, Kansas City.

New Jersey

W. A. Allen, Pittstown.
Barber Asphalt Co., 1935 Lewis St., Maurer.
Joseph Dixon Crucible Co., Jersey City.
Franco-American Chemical Works, Inc., Carlstadt.

New York

Binney & Smith Co., 44 E. 43d St., New York.
Carbola Chemical Co., Inc., 318 Harris Road, Natural Bridge.
General Mineral Co., 90-104 Spring St., New York.
H. A. Golwynne, Golwynne Magnesia & Magnesite Corp., 1532 Chrysler Bldg., New York.
Adolphe Hurst & Co., 328 W. 42d St., New York.
Chas. Mathieu, Inc., 120 Liberty St., New York.
Reichard-Coulston Inc., 95 Madison Ave., New York.
Ruberoid Co., 502 Fifth Ave., New York.
W. H. Scheel, Inc., Water and John Sts., New York.
U. S. Talc Co., 147 Nassau St., New York.
W. H. Whittaker Co., 250 Front St., New York.

Ohio

R. L. Cawood Co., East Liverpool.
B. F. Goodrich Co., 450 S. Main St., Akron.
Goodyear Tire & Rubber Co., Akron.

Pennsylvania

Rock Products Co., Easton.
C. K. Williams Co., 132 Bushkill Creek, Easton.

BUYERS OF SOAPSTONE

California

Commercial Minerals Co., 130 Irwin St., San Francisco.
Pacific Minerals Co., Ltd., 337 10th St., Richmond.

Illinois (Chicago)

Jas. B. Clow & Sons, 2338 S. Western Ave.
Jas. H. Rhodes & Co., 153 W. Austin Ave.

Michigan

Cummings, Moore Graphite Co., 1646 Green St., Detroit.

Missouri

D. C. Adams Crayon Mfg. Co., 125 Market St., St. Louis.

New York

Insulation Mfg. Co., Inc., 15 New York Ave., Brooklyn.

New York City

The Barrett Co., 40 Rector St. (soapstone talc)
Binney & Smith Co., 44 E. 43d St.
Charles B. Chrystal Co., Inc., 16 Hudson St.
General Mineral Co., 96-104 Spring St.
Thos. Stanley, Inc., 473 Canal St.

North Carolina

Georgia Talc Co., Asheville.

Ohio

Goodyear Tire & Rubber Co., Akron.

Pennsylvania

Chas. A. Wagner Co., Inc., 811 Callowhill, Philadelphia.

Tennessee

D. M. Steward Mfg. Co., Chattanooga.

Virginia

F. G. Hoffman, Claremont.

MANGANESE

By George L. Gary, Mineral Technologist

Properties

The most important ores of manganese are psilomelane and pyrolusite, the two minerals often occurring together and quite frequently in alternating layers. They are generally associated with limonite, the common yellow oxide of iron. Psilomelane is essentially manganese dioxide and manganese monoxide with some combined water, barium oxide and small amounts of iron. It is massive and botryoidal, or grape-like, in structure. It is iron-black or dark steel-gray in color, and gives a brownish black streak. The hardness is 5-7; the gravity varies from 3.3 to 4.7. Pyrolusite is a black mineral, which is usually sooty and soft enough to soil the fingers when handled. Its chemical composition is manganese dioxide, MnO_2, but like all ores it contains some impurities such as silica, iron and lime. It is usually columnar, often divergent and granular massive in structure. It is iron-black, dark steel-gray, sometimes bluish in color, and gives a black or bluish black streak. The hardness is 2-2.5, much softer than psilomelane; the gravity varies from 4.73-4.86.

Occurrence

Nearly all commercial manganese deposits are of secondary formation; that is, they are concentrated from manganese minerals more sparsely distributed in rocks. Some manganese occurs in soft gravel or clay formations, but in other places the mineral is found in the form of veins and rounded nodules in limestone and hard rock. Manganese occurs in irregular masses with smooth surfaces in jasper in the Coast Ranges and in slates, shales and igneous rocks of the Sierra Nevada. The majority of the manganese deposits of California are located in the Coast Ranges. They are widely distributed from Siskiyou County, southerly through Trinity, Humboldt, Tehama, Mendocino, Glenn, Lake, Sonoma, and Napa counties. Farther south there is a prominent belt including the easterly portion of Alameda, Santa Clara and San Benito counties and the westerly portion of San Joaquin, Stanislaus and Merced counties. There are several deposits in the northwestern part of San Luis Obispo County. In the foothills of the Sierra Nevada there are numerous deposits, principally in Plumas, Butte, Yuba, Nevada, El Dorado, Amador, Calaveras and Tuolumne counties. A few properties are located in San Bernardino, Riverside, Imperial and Kern counties.

Classification

Manganese ore comprises four different raw materials, determined by grade and quality as follows:

1. Exceptionally high-grade manganese ore characterized by a high content of MnO_2 is used in making batteries. It commands the highest unit price and is known as battery ore, or chemical ore.

2. At the other extreme is manganiferous iron ore, usually containing 10 per cent or less manganese; it is used for making manganiferous pig iron. The domestic supply of such ore is so abundant that the manganese it contains is usually paid for as if it were iron.

Between these two extremes are the ores low in iron that are suitable for making ferromanganese and those high in iron used for making spiegeleisen, although some of it is used for making pig iron.

3. For making ferromanganese, the ore usually contains at least 45 per cent manganese but averages 48 per cent, and the ratio of manganese to iron is not less than 7 to 1 though it usually is 8 to 1, while there must be low silica, ranging from 7 to 10 per cent and very low phosphorus, ranging from 0.12 to 0.2 per cent. Only manganese ore of this character has been designated as a strategic mineral because domestic production is inadequate.

4. Ore in which the manganese-iron ratio is too low for making ferromanganese can be used for making spiegeleisen. Of such manganese ores, high in iron, there is no deficiency, and a relatively low price is paid for the manganese they contain. Although an excess of silica often can be remedied by gravity concentration, iron is difficult to remove by that means because the specific gravities of iron and manganese oxides are so nearly the same.

Uses

The principal use of manganese is in the manufacture of steel. All ordinary steels require some manganese to give essential physical characteristics. No satisfactory substitutes for manganese have been found for this purpose. When large quantities of manganese are added to steel a manganese-steel alloy is formed which is very tough and resistant to abrasion. The battery industry, the ceramic industry, the glass industry, and many chemical industries employ considerable manganese. Usually ores quite high in manganese are required, but various other properties control their suitability for a particular use.

Tests

Make a borax bead by dipping a loop of fine platinum wire into powdered borax, and heating until the powder is reduced to a clear glass. A little of the powder of the manganese mineral will color this bead violet-red in the oxidizing flame, and colorless in the reducing flame. With soda in the oxidizing flame it gives a bluish green bead; this reaction is very delicate and may be relied upon, even in the presence of almost any other metal. Minerals containing any oxide of manganese, higher than the protoxide, such as pyrolusite or psilomelane, evolve chlorine when heated with hydrochloric acid, and this can be detected by its odor.

Markets

Manganese ore, per long ton unit Mn c. i. f. Atlantic ports; Cuban, 51%, duty free, 67-71¢; Brazilian, 46-48%, 55¢ nom.; Domestic, per ton, f. o. b. mines, chemical grades, 70-72% MnO_2, in carload lots $45.-50. Manganese, per lb., 96-98%, f. o. b. New York, 40¢. (Quotations, April 1, 1941.)

Possible Buyers

American Manganese Corp., Box 629, Torrance, Calif.
Bethlehem Steel Corp., Bethlehem, Pa.
Bradley & Ekstrom, 320 Market St., San Francisco, Calif.
Colorado Fuel & Iron Co., Continental Oil Bldg., Denver, Colo.
Columbia Steel Co., Russ Bldg., San Francisco, Calif.
Electro-Metallurgical Co., 30 E. 42d St., New York, N. Y.
Foote Mineral Co., 1609 Sumner St., Philadelphia, Pa.
W. R. Grace & Co., 7 Hanover Square, New York, N. Y.
Chas. Hardy, Inc., 122 E. 42d St., New York, N. Y.
E. J. Lavino & Co., Bullitt Bldg., Philadelphia, Pa.
Ore, Metal & Engineering Corp., 112 Market St., San Francisco, Calif.
Henry Rising & Co., 626 St. Paul Ave., Los Angeles, Calif.
U. S. Steel Corp., 71 Broadway, New York, N. Y.
U. S. Vanadium Corp., 114 Sansome St., San Francisco, Calif.
Vance & Barnes, Ltd., 1131 Park Ave., Alameda, Calif.

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Notes

1. Specimens of manganese ores may be seen in the museum of the California State Division of Mines, Ferry Bldg., San Francisco, Calif.

2. Other manganese minerals of minor commercial value are manganite, hausmannite, braunite and rhodoshrosite.

MAGNESITE

By George L. Gary, Mineral Technologist

Properties

Magnesite is a magnesium carbonate, $MgCO_3$, consisting of magnesium oxide, known as 'magnesia', MgO and carbon dioxide, CO_2. When pure it contains 47.6% MgO and 52.4% CO_2. It is a white, very fine-grained, compact, minutely crystalline mineral. Impure varieties are more or less coarsely crystalline in many colors—white, gray, black, pink or even red. It includes some silica, clay, serpentine and oxides of iron. Magnesite is brittle and has a conchoidal, or shell-like, fracture. The hardness varies from 3½ to 4½ and the gravity varies from 3 to 3.12.

Occurrence

Magnesite is widespread in California because of the great areas of serpentine, of which it is an alteration product. It occurs generally as irregular veins or pockets or as massive beds or as interstratified beds like sedimentary rock. The serpentine is commonly intersected by veins and patches of snow-white to light-buff magnesite. Some of these veins and beds are commercially important. The main deposits lie in the serpentine belts of the Coast Ranges, but deposits also occur in serpentine in the foothills of the Sierra Nevada and elsewhere. Notable exceptions to these deposits in the metamorphic rocks are the sedimentary deposits at Bissell in Kern County and at Afton in San Bernardino County. A portion of the market for calcined magnesite is being supplied by magnesium oxide produced from salt-works bitterns at a plant at Newark, Alameda County, on San Francisco Bay.

Preparation

Magnesite is quarried from open pits or mined by tunnels and stopes, the method employed depending upon the size of the deposit and its relation to the surface. Magnesite is calcined in vertical stack kilns fired with wood, oil or coke and in rotary cylindrical kilns fired with oil or powdered coal. Caustic magnesite is the product resulting from calcining crude magnesite at a temperature of 700° to 1200° C. About 2% to 7% CO_2 is left in the product, since it has been found that a calcination temperature high enough to expel all of the CO_2 would impair the cementing properties of the magnesite. Dead-burned magnesite is the product obtained by calcining magnesite at a temperature of 1450° to 1900° C., thereby the carbon dioxide content is reduced to less than 1%, and the product remains inert in the presence of air, unlike the caustic variety which takes up carbon dioxide on exposure to air. By expelling virtually all of the CO_2 (less than 0.5 percent) the grains are sintered to dense particles suitable for refractory purposes.

Uses

The never-ending search for a light, durable, high-tensile-strength metal or alloy has led to a material increase in the production and use of the metal magnesium, as the lightest structural metal commercially available. The essential industrial use of magnesite is in metallurgy, as a refractory material for lining furnaces. There is no technically satisfactory substitute for magnesite brick. Chrome brick, however, are used for much the same purpose in other zones in the furnace linings. In the building trades the various compounds of magnesite meet the keen competition from other minerals. In the near future it may well be that the market for magnesium metal may increase materially. This suggestion is based upon the fact that the present trends are toward reduction in weight for such commodities as cars, buses, trucks, trailers, airplanes, and portable equipment, and magnesium metal or an alloy may well meet this trend. Should this development take place, keen competition between aluminum, and magnesium, as well as special high-strength alloy steels, will result. Magnesium is one-third lighter than aluminum, and although the volume of production is still small it has become one of its chief competitors. In the manufacture of stucco, plasterboards, and such building materials as base-coat, sanded, finished, and molding plasters, plasterboard and lath, wallboard, partition tiles, and insulating materials, magnesite has many competitors among which it would be difficult to choose substitutes.

Tests

Magnesite is not acted upon by cold dilute hydrochloric acid but dissolves readily with effervescence in hot acid. If the solution is made strongly alkaline with ammonia, and sodium phosphate added, a white crystalline precipitate will be formed. Before testing, however, it must be ascertained whether other substances are present which would tend to form a precipitate. A good procedure is as follows: Dissolve a very small portion of the mineral in a small quantity of boiling hydrochloric acid, add a drop or two of nitric acid and then water, and again heat to boiling. Add ammonia in excess, and filter if there is a precipitate. To the filtrate add ammonium oxalate and again filter if there is a precipitate. Then add sodium phosphate and as noted above a white crystalline precipitate indicates magnesium.

Markets

Magnesite per ton, f.o.b. California, dead-burned, \$25. Caustic, 95% MgO, white color, \$40; 85% MgO, no color standard, \$37.50. Magnesium per pound; ingots (4x16 in.) 99.8%, carload lots, 27¢; 100 lb. or more, l.c.l., 29¢.

Possible Buyers

Bradley & Ekstrom, 320 Market St., San Francisco, Calif.
Leonard J. Buck, Inc., 1 Newark Ave., Jersey City, N. J.
C. B. R. Fitz-Williams and Company, Ltd., 904 Security Bldg., St. Louis, Mo.
The Warner Chemical Co., 405 Lexington Ave., New York, N. Y.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York, N. Y.
Wishnick-Tumpeer, Inc., 295 Madison Ave., New York, N. Y.
American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y.
Westvaco Chlorine Products Corp., Newark, Calif.
Schofield-Donald Co., Inc., 154 Nassau St., New York, N. Y.

Bibliography

G. W. Bain: Types of Magnesite Deposits and their Origin. Econ. Geol. (1924) 19, 412-433.

Walter W. Bradley: Magnesite in California. California State Division of Mines. Bull. 79 (1925).

C. F. Floe: Magnesium Metal from Washington Magnesite and Dolomite Deposits. State College of Washington Met. Research Bur. Bull. B (1934).

Herbert A. Franke and M. E. Trought: Magnesium. Minerals Yearbook, (1940), U. S. Bur. Mines, 717-725.

F. L. Hess: The Magnesite Deposits of California. U. S. Geol. Survey Bull. 355 (1908).

J. S. McDowell and R. M. Howe: Magnesite Refractories. Jnl. Amer. Cermaic Soc. (March 1920) 3, 185-246. This is a good general treatise on magnesite occurrences, mining and utilization.

O. C. Ralston, R. D. Pike and L. H. Duschak: Plastic Magnesia. U. S. Bur. Mines Bull. 236 (1925).

P. M. Tyler: Magnesite. U. S. Bur. Mines Inf. Circ. 6437 (May 1931).

Notes

1. Specimens of magnesite may be seen in the museum of the California State Division of Mines, Ferry Building, San Francisco, California.

2. The demand for magnesite greatly increased during the European War, 1914-1918, because of its extensive use for refractory linings in all kinds of smelting furnaces, and because of its numerous other applications which made it indirectly of great value as a war mineral. As a refractory it is a substitute for chromite. It thus released much of the latter mineral for use in the manufacture of steel.

3. Other magnesium minerals of commercial value are dolomite and brucite which will be covered in other papers in this series. In addition, there are more than 100 magnesian minerals occurring either in small amounts or in such chemical combinations as not to be economically recoverable at the present time.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

There have been no changes in personnel to be noted, during the past three months.

New Publications

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, October 1940, being Chapter 4 of State Mineralogist's Report XXXVI. This chapter contains: "Mineral Resources of the Kernville Quadrangle"; "Strategic Problems of the Mineral Industry in California"; "Descriptive Geology of the Kernville Quadrangle, California"; "Biennial Report of the State Mineralogist"; "Strategic Tax Exemption"; "Federal Loans for Strategic Minerals." It contains the index for the entire volume.

COMMERCIAL MINERAL NOTES (Nos. 214, 215, 216) February, March, April, 1941, respectively. These 'Notes' contain the lists of 'mineral deposits wanted' and 'mineral deposits for sale,' issued in the form of mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to five pages in recent months.

Mail and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco Office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum

By Henry H. Symons, Statistician and Curator

STATISTICS

The counties of California have produced for some years past more than 50 different mineral substances, the total of which was estimated at $343,536,000 for 1940. See January, 1941, issue of the California Journal of Mines and Geology.

At present (April, 1941) reports for most of the producers are in hand. Data for several substances are now complete and have been compiled, being presented herein. Information at hand indicates that there was no commercial production during 1940 of the following: asbestos, bismuth, fluorspar, graphite, mica, mineral paint, serpentine, shale oil, or tin.

There was a single producer of each of the following: bromine, lithia, molybdenum ore, magnesite, potash, pyrite, strontium, titanium and wollastonite.

SALINES

Bibliography: State Mineralogist Reports III, XIV, XV, XVII-XXIX (inc.), XXXIII-XXXV (inc.). Bulletin 24. Spurr and Wormser, ''Marketing of Minerals.'' ''Non-Metallic Minerals,'' by R. B. Ladoo. ''Industrial Minerals and Rocks,'' A. I. M. E., 1937. See also under each substance.

Under this heading are included borax, common salt, soda, potash, and other alkaline salts. The first two have been produced in a number of localities in California, more or less regularly since the early sixties. Except for a single year's absence, soda has had a continuous production since 1894. Potash, magnesium chloride and sulphate, and calcium chloride have been added to the commercial list in recent years, joined in 1926 by bromide, and in 1931 by iodine and in 1938 by the alum minerals. The nitrates are still prospective.

Our main resources of salines are the lake beds of the desert regions of Imperial, Inyo, Kern, Los Angeles, San Bernardino, and San Luis Obispo counties, and the waters of the Pacific Ocean.

The total value of this group showed an increase from $13,178,499 in 1939, to $13,674,519 in 1940.

The following table gives details for each year:

Substance	1939		1940		Increase+ Decrease— Value
	Amount	Value	Amount	Value	
Borates	244,819 tons	$5,110,807	212,358 tons	$5,254,154	$143,347+
Magnesium salts	3,895 tons	382,457	4,325 tons	419,666	37,209+
Salt	417,956 tons	1,174,386	462,282 tons	1,290,728	116,347+
Soda	200,049 tons	2,055,608	228,108 tons	2,339,639	284,031+
Unapportioned		[A]4,455,241		[A]4,370,332	84,909—
Total value		$13,178,499		$13,674,519	
Net increase					$496,020+

[A] Includes bromine, calcium chloride, iodine, and potash.

ALUM MINERALS

Bibliography: State Mineralogist Report XXXV.

There are several minerals found in California that are considered natural alums. They are hydrous aluminum sulphates combined with sulphates of iron, potassium, sodium or magnesium. The most important are: Alunite, $K_2Al_6(OH)_{12}(SO_4)_4$, a basic hydrous aluminum and potassium sulphate, and Alunogen, $Al_2(SO_4)_3.16H_2O$, an hydrous aluminum sulphate.

In 1938 a small production and some development work was done on an alunogen deposit near Corona, Riverside County. This output was the first recorded commercial production reported in California. The annual details are combined under 'Unapportioned' item to conceal the output of the single operator. An alunite deposit near Glen Ellen, Sonoma County, was opened up several years ago and some development work has been done in hopes of commercializing this mineral.

BORATES

Bibliography: State Mineralogist Reports III, X, XII-XV (inc.), XVII-XXIII (inc.), XXV-XXVII (inc.), XXXIII-XXXIV. Bulletins 24, 67, 91.

During 1940 there was produced in California a total of 242,419 tons of borate materials compared with 238,390 tons for the year 1939. The material shipped during the year included the sodium borates, kernite (rasorite), kramerite from Kern County; also crystallized borax prepared by evaporation of brines at Searles Lake in San Bernardino County and Owens Lake in Inyo County.

As the crude ore is not sold as such, but is almost entirely refined into borax of commerce before shipping, and because of the fact that the material varied widely in boric acid content, we have recalculated the tonnage to a basis of 40 per cent A.B.A. This is approximately the average A.B.A. content of colemanite material after calcining, and also of the crystallized borax obtained from evaporation of the lake brines.

Recalculated as above, the 1940 production totaled 212,358 tons valued at $5,254,154. This was a decrease in quantity and a slight increase in value from the 1939 output, which was 244,819 tons worth $5,110,807.

The total amount of borates exported from the United States[1] during the year 1940 was 64,313 tons valued at $2,456,523, as compared with 91,139 tons valued at $3,230,304 in 1939.

Total Production of Borate Materials in California

Borax was first discovered in California in the waters of Tuscan Springs in Tehama County, January 8, 1856. Borax Lake in Lake County was discovered in September of the same year by Dr. John A. Veach. This deposit was worked in 1864-1868, inclusive, and during that time produced 1,181,365 pounds of refined borax. The bulk of it was exported by sea to New York. This was the first commercial output of this salt in the United States, and California is still today the leading American producer of borax, having been for many years the sole producer. California is also the premier world source, today.

Production from the dry lake 'playa' deposits of Inyo and San Bernardino counties began in 1873; but it was not until 1887 that the borax industry was revolutionized by the discovery of the colemanite beds at Calico, in San Bernardino County and later similar beds in Inyo and Los Angeles counties. The colemanite deposits of Ventura County were not worked extensively, owing to lack of transportation facilities. Some production of colemanite has been made from deposits opened up in Clarke County, Nevada. Colemanite was in turn, displaced by the discovery in 1926 of kernite (rasorite) a sodium borate and probertite (kramerite) a hydrous sodium, and calcium borate, near Kramer in Kern County. The brines of Searles Lake are likewise an important source.

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[1] Monthly Summary of Foreign Commerce of the United States, Department of Commerce, Dec., 1940, Part 1.

The total production of borate materials in California is shown in the following table:

Total Production of Borate Materials in California

Year	Tons	Value	Year	Tons	Value
1864	12	$9,478	1903	34,430	$661,400
1865	126	94,099	1904	45,647	698,810
1866	201	132,538	1905	46,334	1,019,158
1867	220	156,137	1906	58,173	1,182,410
1868	32	22,384	1907	53,413	1,200,913
1869	--------	--------	1908	22,200	1,117,000
1870	--------	--------	1909	16,628	1,163,960
1871	--------	--------	1910	16,828	1,177,960
1872	140	89,600	1911	50,945	1,456,672
1873	515	255,440	1912	42,135	1,122,713
1874	915	259,427	1913	58,051	1,491,530
1875	1,168	289,080	1914	62,500	1,483,500
1876	1,437	312,537	1915	67,004	1,663,521
1877	993	193,705	1916	103,523	2,409,375
1878	373	66,257	1917	109,944	2,561,958
1879	364	65,443	1918	88,772	1,867,908
1880	609	149,245	1919	66,791	1,717,192
1881	690	189,750	1920	127,065	2,794,206
1882	732	201,300	1921	50,136	1,096,326
1883	900	265,500	1922	[2]39,087	1,068,025
1884	1,019	198,705	1923	62,667	1,893,798
1885	942	155,430	1924	52,070	1,599,149
1886	1,285	173,475	1925	46,124	1,526,938
1887	1,015	116,689	1926	47,605	1,625,298
1888	1,405	196,636	1927	72,462	3,043,260
1889	965	145,473	1928	109,722	3,378,552
1890	3,201	480,152	1929	144,678	3,312,085
1891	4,267	640,000	1930	209,869	3,686,817
1892	5,525	838,787	1931	206,405	5,753,037
1893	3,955	593,292	1932	179,356	2,856,470
1894	5,770	807,807	1933	197,495	3,019,513
1895	5,959	595,900	1934	240,696	5,524,262
1896	6,754	675,400	1935	280,249	4,602,064
1897	8,000	1,080,000	1936	313,389	5,911,093
1898	8,300	1,153,000	1937	326,099	6,206,619
1899	20,357	1,139,882	1938	276,144	5,014,237
1900	25,837	1,013,251	1939	244,819	5,110,807
1901	22,221	982,380	1940	212,358	5,254,154
1902	[1]17,202	2,234,994			
			Totals	4,535,219	$114,245,863

[1] Refined borax. [2] Recalculated to 40% 'anhydrous boric acid' equivalent beginning with 1922.

BROMINE

The first commercial production of bromine and bromine compounds was begun during 1926 by the California Chemical Corporation in its plant at Chula Vista, San Diego County, from salt-works bittern waters. This same plant has been recovering magnesium chloride for a number of years. Bromine is also now being made at a similar bittern-water plant at Newark, Alameda County, and beginning in 1940 from brines at Searles Lake, San Bernardino County. The 1940 output, an increase in amount and value as compared with that of 1939, was the largest annual production on record in California; annual details of which are concealed under the 'Unapportioned' item so as not to reveal the production of the single company which operated both plants.

The total commercial production of bromine in California is as follows:

Year	Tons	Value	Year	Tons	Value
1926 1927 * 1928	158	$120,480	1932 1933 * 1934	559	$146,547
1929 1930 * 1931	802	552,933	1935 1936 *	805	191,465
			1937 1938 *	914	327,823
			1939 1940	1,579	528,245
			Totals	4,817	$1,867,493

*Annual details concealed under 'Unapportioned.'

CALCIUM CHLORIDE

Bibliography: U. S. Geol. Surv., Min. Res. 1919, Pt. II. Engineering and Contracting, Roads and Streets, monthly issue, Feb. 6, 1924. 'How to Maintain Roads,' manual of instruction of Dow Chemical Company.

Calcium chloride is hygroscopic, that is, it has an affinity for water. This property is taken advantage of by utilizing this salt as a drying agent. During 1940 the production of calcium chloride in California came from one plant in San Bernardino County. The annual details are combined under the 'Unapportioned' item to conceal the output of the operator. The 1940 output showed an increase in both amount and value as compared with that of 1939.

Total Calcium Chloride Production in California

Commercial production of calcium chloride in California was first reported to the State Mining Bureau in 1921, from two plants in San Bernardino County, being obtained as a by-product in the refining of salt from deposits in certain of the desert dry lakes. Total production in California is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1921	683	$22,980	1930 1931 *	9,688	$103,237
1922 1923 *	1,204	26,580	1932 1933 *	3,103	15,500
1924 1925 *	10,988	328,876	1934 1935 *	4,048	16,196
1926 1927 *	34,195	508,748	1936 1937 *	7,227	35,073
1928 1929 *	12,020	114,080	1938 1939 *	7,279	40,182
			1940	*	*
			Totals	90,435	$1,211,452

* Annual details concealed under 'Unapportioned.'

IODINE

Bibliography: State Mineralogist Report XXXIV. U. S. Bureau of Mines I. C. 6387.

In 1940 the output of iodine in California came from two plants in Los Angeles County and showed an increase in both quantity and value over 1939. The annual details for 1940 are concealed under the 'Unapportioned' item to conceal the output of either operator. The combined 1939–1940 production came from three plants in Los Angeles County, and amounted to 795,510 pounds, valued at $862,931.

Total Iodine Production in California

Iodine was first produced in California during 1917 to 1921 as a by-product of potash which was reduced from kelp in an experimental station of U. S. Department of Agriculture at Summerland, but after the armistice the demand for these minerals decreased so that the plant in Santa Barbara County closed. In 1929 the General Salt Company erected a plant which reduces iodine from the waste waters of certain deep oil wells in the Long Beach field. During 1933 two more plants started operation, making a total of three producing plants in the State.

Year	Pounds	Value
1929 1931 1933 *	696,297	$1,374,311
1934	355,279	423,016
1935 1936 *	487,401	379,702
1937 1938 *	624,318	508,119
1939 1940 *	795,510	862,931
Totals	2,958,805	$3,521,079

*Annual details concealed under 'Unapportioned.'

MAGNESIUM SALTS

Bibliography: State Mineralogist Reports XX, XXI, XXV-XXVI (inc.), XXXIV. Bulletin 91. 'Dictionary of Applied Chemistry,' by Thorpe. U. S. Geol. Surv., Min. Res. of P. S.

During 1940 there was an output of magnesium salts in California coming from one plant in San Diego County, and two in San Mateo County amounting to 4,325 short tons valued at $419,666, and consisted of the chloride, carbonate, hydroxide, and oxide. The 1939 output amounted to 3,895 tons worth $382,457, which was also the chloride, carbonate, hydroxide, and oxide. Also coming from Alameda County was a tonnage of magnesium hydroxide but not included in the above totals as this material was used as magnesite and therefore included under that substance. The chloride was nearly all sold for use in magnesite stucco and cement mixtures (Sorel cement), also some for road liquor. The carbonate, or bulky white powder, was used as a heat-insulating material, as a substitute for magnesite, as a filler for rubber, paper, paint, etc., and in medicines, in tooth paste, in face powder and as a polish for metal and glass. The sulphate market in past years was utilized for medicinal and bath purposes. The material coming from San Diego County was residual bitterns from the salt plants and was in part marketed in the liquid form carrying from 35% to 67% $MgCl_2$ and in part as dry crystals, while that from Alameda and San Mateo counties was magnesium carbonate, magnesium hydroxide, and magnesium oxide, obtained by precipitation from sea water.

The average value reported from the chloride produced in California in 1940 was approximately $29.84 per ton, f. o. b. plant, and in 1939 approximately $28.80 per ton, f. o. b. plant.

Total Production of Magnesium Salts in California

Commercial production of magnesium chloride in California was begun in 1916 by some of the salt companies, from the residual bitterns obtained during the evaporation of sea water for its sodium chloride. In addition, some magnesium sulphate, or 'epsom salts' has also been made, but in smaller amount, and magnesium carbonate by a patented process, direct from sea water.

The total production of magnesium salts in California, since the beginning of the industry here, is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1916	851	$6,407	1929 1930*	4,914	$333,906
1917	1,064	34,973	1931 1932*	2,749	217,979
1918	1,008	29,955	1933	2,073	159,660
1919	1,616	82,457	1934	2,325	194,642
1920	3,150	107,787	1935	2,785	235,531
1921	4,153	106,140	1936	3,798	347,838
1922	3,036	89,788	1937	3,867	316,669
1923	3,662	116,031	1938	24,176	469,636
1924	4,823	145,883	1939	3,895	382,457
1925	4,221	132,553	1940	4,325	419,666
1926	4,881	124,470			
1927 1928*	6,241	139,589			
			Totals	93,613	$4,194;017

* Annual details concealed under 'Unapportioned.'

NITRATES

Bibliography: State Mineralogist Reports XV, XXV, XXVI, XXVII, XXXIV. Bulletins 24, 67, 91. U. S. G. S., Press Bulletin No. 373, July, 1918. Smithsonian Inst., Publ. No. 2421, 1916.

Nitrates of sodium, potassium and calcium have been found in various places in the desert regions of the State, but no deposit of commercial value has been developed as yet. It is hoped that a closer search may some day be rewarded by workable discoveries. At present the principal commercial source of nitrates is the Chilean saltpeter (sodium nitrate) deposits in South America.

The fixation of atmospheric nitrogen electrically has been accomplished successfully in Germany and Scandinavia. The possibilities of cheap hydroelectric power in California make the subject one of interest to us, as we have also the natural raw materials and chemicals to go with the explosives. Sodium and potasium cyanides can be made by fixation of atmospheric nitrogen electrically.

POTASH

Bibliography: State Mineralogist Reports XV, XVIII, XX, XXII, XXV-XXVII (inc.) XXXIV. Bulletins 24, 67, 91. U. S. G. S., Min. Res. 1913, 1914, 1915. Senate Doc. No. 190, 62 Congress, 2d Session. Mining & Sci. Press, Vol. 112, p. 155; Vol. 114, p. 789. Eng. & Min. Jour.-Press, Vol. 117, p. 557, Apr. 5, 1924.

The 1940 production of potash in California came from a single operator in San Bernardino County, the details of which are concealed under the 'Unapportioned' item. This was principally chloride and the product averaged 60% equivalent K_2O content. The material was sold mainly for fertilizer manufacture.

Imports of crude potash minerals and salts in the United States during 1940 according to the U. S. Bureau of Foreign and Domestic Commerce amounted to 246,065 long tons valued at $5,148,852, compared with 210,818 long tons worth $5,752,225 in 1939. These materials consisted mainly of 'manure salts,' crude chloride (muriate) and sulphate, and kainite, all of which are admitted duty free.

Quotations (July 7, 1941) were $36.25 per ton c. i. f. Atlantic and Gulf ports for high grade sulphate (90%-95%).

Total Production of Potash in California

Potash production began commercially in California in 1914, with a small yield from kelp. Practically all of the output now comes from deposits of potash-bearing residues and brines in the old lake beds of the desert regions, particularly Searles Lake, San Bernardino County. A small amount has been made from salt-works bitterns, and for a time there was some from Portland cement dust. Some also has been obtained from molasses distillery-slops char.

The annual amounts and values of these potash materials, since their beginning in California in 1914, have been as follows:

Year	Tons	Value	Year	Tons	Value
1914	10	$460	1928 1929 *	178,680	$5,522,350
1915	1,076	19,391			
1916	17,808	663,605	1930 1931 *	172,263	5,500,536
1917	129,022	4,202,889			
1918	49,381	6,808,976	1932 1933 *	153,147	3,932,721
1919	28,118	2,415,963			
1920	26,298	1,465,463	1934 1935 *	355,604	3,750,809
1921	14,806	390,210			
1922	17,776	584,388	1936 1937 *	358,417	6,988,922
1923	29,597	709,836			
1924	33,107	747,407	1938 1939 *	383,981	9,057,866
1925	36,355	829,770			
1926	32,884	812,285	1940	*	*
1927	67,340	1,952,852			
			Totals	1,985,770	$55,361,699

* Annual details concealed under 'Unapportioned.'

SALT

Bibliography: State Mineralogist Reports II, XII-XV (inc.), XVII-XXIII (inc.), XXV-XXVII (inc.), XXXIV-XXXV. Bulletins 24, 67, 91. U. S. Geol. Survey, Bull. 669. U. S. Bur. of Mines, Bull. 146.

Most of the salt production in California is obtained by evaporation of water of the Pacific Ocean, plants being located on the shores of San Francisco, Monterey, and San Diego bays, and at Long Beach. Additional amounts are derived from lakes and lake beds in the desert regions (in part, rock salt), mainly in Imperial, Kern, and San Bernardino counties, and evaporation of alkaline lake water in Modoc County. A small amount of valuable medicinal salts has been obtained by evaporation of the water of Lake Mono, Mono County, and from a mineral spring in Butte County.

During 1940 there was an output in California of 462,282 short tons of salt valued at $1,290,728, compared with 417,956 tons worth $1,174,386.

There were sixteen operating plants in 1940; three in Alameda County; two each in Imperial and San Bernardino counties; and one each in Butte, Kern, Los Angeles, Mono, Modoc, Monterey, Orange, San Diego, and San Mateo counties.

The average value reported for salt produced in California during 1940 was $2.79 per ton f.o.b. plant, compared with $2.75 in 1939, $2.82 in 1937, $3.08 in 1936, and $3.36 in 1935.

Production of Salt in California, by Years

Although salt has been made in California since the early '60's, there are no definite or authenticated records for the earlier years before the beginning of the statistical tabulations by the State Mining Bureau.

Amount and value of annual production of salt in California from 1887 is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	28,000	$112,000	1915	169,028	$368,737
1888	30,800	92,400	1916	186,148	455,695
1889	21,000	63,000	1917	227,825	584,373
1890	8,729	57,085	1918	212,076	806,328
1891	20,094	90,303	1919	233,994	896,963
1892	23,570	104,788	1920	230,638	972,648
1893	50,500	213,000	1921	197,989	832,702
1894	49,131	140,087	1922	223,238	819,187
1895	53,031	150,576	1923	275,979	1,130,670
1896	64,743	153,244	1924	318,800	1,159,137
1897	67,851	157,520	1925	284,068	949,826
1898	93,421	170,855	1926	311,761	1,124,978
1899	82,654	149,588	1927	263,028	639,127
1900	89,338	204,754	1928	340,580	1,024,656
1901	126,218	366,376	1929	392,039	2,665,436
1902	115,208	205,876	1930	347,945	1,167,487
1903	102,895	211,365	1931	330,951	1,233,567
1904	95,968	187,300	1932	256,353	918,480
1905	77,118	141,925	1933	321,312	1,251,024
1906	101,650	213,228	1934	332,194	1,222,810
1907	88,063	310,967	1935	365,711	1,230,480
1908	121,764	281,469	1936	398,249	1,227,505
1909	155,680	414,708	1937	370,431	1,044,325
1910	174,920	395,417	1938	395,746	1,099,737
1911	173,332	324,255	1939	417,956	1,174,386
1912	185,721	383,370	1940	462,282	1,290,728
1913	204,407	462,681			
1914	223,806	583,553	Totals	10,494,933	$33,632,682

SODA

Bibliography: State Mineralogist Reports XII, XIII, XV, XVII, XVIII, XX, XXII, XXIII, XXV-XXIX (inc.), XXXIV. Bulletins 24, 67, 91. U. S. Geol. Surv., Bull. 717.

The production of sodium salts in California in 1940 included soda ash, and trona, from plants at Owens Lake, Inyo County; and soda ash, salt cake, and trona (sequi-carbonate, a double salt of Na_2CO_3 and $NaHCO_3$) from Searles Lake, San Bernardino County. The plant on Dale Lake near Amboy, San Bernardino County, started operations during the year and should make shipments of salt cake in 1941. There were no shipments of salt cake (sulphate) from Carrizo Plains, San Luis Obispo County.

Shipments in 1940 amounted to 228,108 short tons valued at $2,339,639, as compared with 200,049 tons worth $2,055,608 in 1939. The 1940 output of soda was the largest annual production reported in California.

The soda ash was used mainly in the manufacture of soap, glass, paper, oil refining, sugar refining, and chemicals; and the trona for metallurgical purposes. The salt cake or sodium sulphate was used in the manufacture of paper, glass, and in chemicals.

Soda Production of California, by Years

The total output, showing amount and value of these materials in California since the inception of the statistical records of the State Mining Bureau, is given in the table which follows:

Year	Tons	Value	Year	Tons	Value
1894	1,530	$20,000	1918	20,447	$855,423
1895	1,900	47,500	1919	21,294	721,958
1896	3,000	65,000	1920	32,407	1,164,898
1897	5,000	110,000	1921	14,828	438,996
1898	7,000	154,000	1922	20,084	573,661
1899	10,000	250,000	1923	34,885	764,284
1900	1,000	50,000	1924	32,536	711,796
1901	8,000	400,000	1925	48,625	947,649
1902	7,000	50,000	1926	63,333	1,305,802
1903	18,000	27,000	1927	62,571	1,478,239
1904	12,000	18,000	1928	80,838	1,469,297
1905	15,000	22,500	1929	90,646	1,838,657
1906	12,000	18,000	1930	90,122	1,627,344
1907	----------	----------	1931	78,701	1,217,811
1908	9,600	14,400	1932	58,017	826,369
1909	7,712	11,593	1933	70,598	1,019,130
1910	8,125	11,862	1934	99,380	1,219,561
1911	9,023	52,887	1935	125,504	1,341,045
1912	7,200	37,094	1936	144,314	1,412,788
1913	1,861	24,936	1937	153,685	1,461,057
1914	6,522	115,396	1938	178,105	2,023,610
1915	5,799	83,485	1939	200,049	2,055,608
1916	10,593	264,825	1940	228,108	2,339,639
1917	24,505	928,578			
			Totals	2,241,447	$31,591,678

DIRECTORY OF SALINE PRODUCERS FOR 1940

BORATES

Operator	Address	Location of property
Inyo County		
Pacific Alkali Co.	1209 Pacific Mutual Bldg., Los Angeles	Bartlett
United States Borax Co.	510 W. 6th St., Los Angeles	Death Valley
Kern County		
Pacific Coast Borax Co.	510 W. 6th St., Los Angeles	Kramer
San Bernardino County		
American Potash and Chemical Corp.	Trona	Trona
West End Chemical Co.	Latham Square Bldg., Oakland	West End

BROMINE

Operator	Address	Location of property
Alameda County		
Westvaco Chlorine Prod. Corp.	Newark	Newark
San Bernardino County		
American Potash & Chem. Co.	Trona	Trona
San Diego County		
Westvaco Chlorine Prod. Corp.	Newark	San Diego

CALCIUM CHLORIDE

Operator	Address	Location of mine
San Bernardino County		
California Rock Salt Co.	2465 Hunter St., Los Angeles	Amboy

DIRECTORY OF SALINE PRODUCERS FOR 1940—Continued

IODINE

Operator	Address	Mine
Los Angeles County		
Deepwater Chemical Co., Ltd.	Box 588, Compton	Compton
The Dow Chemical Co.	Midland, Mich.	Long Beach and Venice

MAGNESIUM SALTS

Operator	Product	Address	Location of plant
Alameda County			
Westvaco Chlorine Prod. Corp.	Hydroxide	Newark	Newark
San Diego County			
Westvaco Chlorine Prod. Corp.	Chloride	Newark	San Diego
San Mateo County			
Marine Magnesium Prod. Corp., R. E. Clarke	Carbonate hydroxide and oxide	South San Francisco	South San Francisco
Plant Rubber & Asbestos Works	Carbonate	537 Brannan St., San Francisco	Redwood City

POTASH

Operator	Address	Location of plant
San Bernardino County		
American Potash and Chemical Co.	Trona	Trona

SALT

Operator	Address	Location of plant
Alameda County		
American Salt Co., Mrs. Mary Marsicano	2970 Lake St., San Francisco	Mt. Eden
Leslie Salt Co.	310 Sansome St., San Francisco	Newark and Mt. Eden
Oliver Brns. Salt Co.	Mt. Eden	Mt. Eden
Butte County		
Richardson Mineral Springs, Lee Richardson, Mgr.	Richardson Springs	Richardson Springs
Imperial County		
Imperial Salt Co.	4000 E. Washington Blvd., Los Angeles	Calipatria
Mullet Island Salt Works	Niland	Niland
Kern County		
Long Beach Salt Co.	P.O. Box 28, Long Beach	Saltdale
Los Angeles County		
Long Beach Salt Co.	P.O. Box 28, Long Beach	Long Beach
Modoc County		
Surprise Valley Salt Works, Joshua H. Hutchinson	Box 26, Cedarville	Lake City
Mono County		
C. C. Miller	837 W. Los Angeles St., Baldwin Park	Mono Lake
Monterey County		
Monterey Bay Salt Co., E. C. Vierra, Mgr.	Moss Landing	Moss Landing
Orange County		
The Irvine Co.	Tustin	Tustin
San Bernardino County		
California Rock-Salt Co.	2465 Hunter St., Los Angeles	Amboy
Rock Salt Products Co.	845 El Centro St., South Pasadena	Salt Marsh
San Diego County		
Western Salt Co.	1245 National Ave., San Diego	San Diego
San Mateo County		
Stauffer Chemical Co.	636 California St., San Francisco	Redwood City

DIRECTORY OF SALINE PRODUCERS FOR 1940—Continued

SODA

Operator	Product	Address	Location of plant
Inyo County			
Natural Soda Products Co.	a, d	405 Montgomery St., San Francisco	Keeler
Pacific Alkali Co.	a, d	1206 Pacific Mutual Bldg., Los Angeles	Bartlett
San Bernardino County			
American Potash & Chemical Co.	a, c	Trona	Trona
Desert Chemical Co.*	c	4031 Goodwin Ave., Los Angeles	Amboy
West End Chemical Co.	a	Latham Square Bldg., Oakland	West End

a. Soda Ash. c. Salt Cake. d. Trona.
* Will be in production in 1941.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

The exhibit is daily visited by engineers, students, businessmen, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

21042 SCHEELITE (crystals) $CaWO_4$.
Locality: Morongo Mining District, San Bernardino County, California. Donor: Billy Baur. February, 1941. Case No. 150.

21043 CHROMITE (black) streaked with UVAROVITE (green).
Locality: Del Norte County, California. Donor: Amy O. Emmons. February, 1941. Case No. 205.

21044 OPAL.
Locality: San Bernardino County, California. Donor: J. K. Hodgson. February, 1941. Case No. 225.

21045 GOLD-BEARING CALCITE.
Locality: Calhor Mine, Baguio, Benguet, Philippine Islands. Donor: T. G. Muth. March, 1941. Case No. 243.

21046 FIRE CLAY.
Location: Ryan Ranch, Tesla, Alameda County, California. Donor: Isbell Bros. March, 1941. Case No. 403.

21047 SILVER ORES.
Locality: Calico District, San Bernardino County, California. Donor: Mrs. J. R. Lane. March, 1941. Case No. 226.

21048 COAL.
Locality: Hoopa Indian Reservation, Humboldt County, California. Donor: Col. Morrison. March, 1941. Case No. 208.

21049 DIOPTASE—H_2CuSiO_4—(emerald green) associated with CERUSSITE crystals (white), some galena, and chrysocolla.
Locality: Mammoth Mine, Tiger, Pinal County, Arizona. 500-ft. level. Donor: St. Anthony Lead Co. March, 1941. Case No. 130.

21050 Native TELLURIUM, with considerable silica.
Locality: About ten miles southwest of Montezuma, Sonora, Mexico. Donor: E. D. Morton. May, 1941. Case No. 101.

21051 GOLD in Quartz (5 pieces). Locality: San Mauricio Mine, Marsman & Co., Paracales Dist., P. I. Donor: E. A. Nicolai. June, 1941.

21052 TECTITE.
Locality: Coco Grove placer operations, Marsman & Co., of Paracales Dist., P. I. Donor: E. A. Nicolai. June, 1941.

21053 Dendritic GOLD on quartz.
Locality: Potosi Mine, Salvador, Central America. Donor: E. A. Nicolai. June, 1941.

21054 Ruby Silver PYRAGYRITE associated with Sphalerite, Tetrahedrite, Galena, and Chalcopyrite in Quartz. Locality: Property of Lava Cap Gold Mining Corp., Nevada City, Nevada County, California. Banner 400 level. Donor: Lava Cap Gold Mining Corp. May, 1941. Case No. 220.

21055 CASSITERITE, SnO_2 (in bottles) recovered by hydraulicking and dredging. Crystals from deposit on contact (decomposed) of granite and limestone. Locality: Taknapa, Siam (Thailand). Donor: S. Hancock. June, 1941.

LABORATORY

George L. Gary, Mineral Technologist

Since 1866 many lists have been published showing localities of California minerals. The last one, "Minerals of California," by Adolph Pabst, was published in 1938 by the Division of Mines as Bulletin No. 113.

It is the intention of the Division of Mines to publish in the quarterly new localities for minerals that are received by the laboratory for determination. So that this information may be accurate, it is requested that all specimens submitted for classification be accompanied by a letter giving the exact location where the material was found.

Corrections will also be noted as well as additions when called to our attention.

CORRECTIONS AND ADDITIONS TO BULLETIN 113

104. **Cassiterite,** a tin oxide, was found in dolomitic limestone 6 miles northwest of Cima and 12 miles south of Valley Wells, San Bernardino County.

105. **Stilbite,** a hydrous sodium, calcium and aluminum silicate has been reported from San Francisco County.

106. Correction, Bulletin No. 113, page 133. The occurrence of psilomelane noted under Monterey County as 3 miles north of the mouth of San Carpojaro Creek and 1 mile inland should be noted under San Luis Obispo County, and San Carpojaro should be San Carpoforo.

LIBRARY

JOHN C. O'BRIEN, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of Federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, CALIFORNIA JOURNAL OF MINES AND GEOLOGY contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE SPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National

U. S. Geological Survey

Bulletins

- 914 Microscopic Determination of the Ore Minerals.
- 915A Geophysical Abstracts—January-March, 1939.

Water Supply Papers

- 843 The Floods of December, 1937, in Northern California.

Topographic Maps

- Camp Baldy Quadrangle, Los Angeles Co.
- Camp Bonita Quadrangle, Los Angeles Co.
- Evey Canyon Quadrangle, Los Angeles Co.
- Mt. Emma Quadrangle, Los Angeles Co. (Adv. Sheet).
- Truckee Quadrangle, California-Nevada.

U. S. Bureau of Mines

Bulletins

- 419 Metal-Mining Practice.
- 421 The Joseph A. Holmes Safety Association and Its Awards.
- 423 Mechanical Shoveling in Underground Metal Mines.
- 426 Quarry Accidents in the U. S., 1937.
- 428 Metal-Mine Accidents in the U. S., 1938.
- 430 Coal Mine Accidents in the U. S., 1937.

Miners' Circulars

- 40 Some Information in Timbering Bituminous Coal Mines.
- 41 Accidents from Falls of Rock or Ore in Metal Mines.

Economic Paper

- 20 Petroleum Statistics.
- 21 Trends and Seasonal Variations in Factors Influencing Domestic Motor Field Demand.

Technical Papers

- 603 Phenomena in the Ignition of Firedoings by Explosives.
- 608 Safety Factors in Construction and Ventilation, Wawona Vehicular Tunnel, Yosemite National Park, Calif.
- 609 Bentonite: Its Properties, Mining, Preparation and Utilization.
- 610 Correlation Index to Aid in Interpreting Crude-Oil Analysis.
- 613 Development in Coal Research and Technology in 1937 and 1938.

Report of Investigations

3469 R, 3490, 3491, 3496, 3498, 3500;—3502, including 31; and 34.

Information Circulars 6312, 6751 R; 7091, 7095, 7096; 7098, 7101; 7102; 7106-7108; 7110 incl. 7132.

U. S. Geological Survey

Bulletins, Water Supply Papers, Topographic Maps.

U. S. Bureau of Mines

Bulletins, Economic Papers, Technical Papers, Report of Investigations, Information Circulars.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.

New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries, Portland.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers, New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.

National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Acadamy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Conservationist, Sacramento, California.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining World, Seattle.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Cheney, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.

Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Courier Free Press, Redding, California.
Daily Commercial News, San Francisco, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Humboldt Beacon, Humboldt.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mining Press, Reno, Nevada.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Owens Valley Progress-Citizen, Lone Pine, California.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
Randsburg Times, Randsburg, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

Books

Golden Mirages by Philip A. Bailey.
Cyaniding for Gold by Ion L. Idriess.
Handbook of Sources of Economic Data pertaining to California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-six years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

Write for latest revised price list.

REPORTS

Asterisks (**) indicate the publication is out of print.	Price (including postage and sales tax)
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks—Price $0.75, sales tax $0.02	$0.77
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr. Price $0.75, sales tax $0.02	.77
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.—Price $1.50, sales tax $0.05	1.55
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
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DEPARTMENT OF NATURAL RESOURCES
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DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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QUARTERLY CHAPTER
OF
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STATE DIVISION OF MINES
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1536

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TABLE OF CONTENTS

Page

DISTRICT REPORTS OF MINING ENGINEERS ---------------------- 373
  Sacramento Field District -- 374
    Mineral Resources of Nevada County, by C. A. Logan -------------- 374
  San Francisco Field District -- 373
  Los Angeles Field District --- 373
  Redding Field District --- 373

GEOLOGIC BRANCH -- 469
  Current Notes --- 469

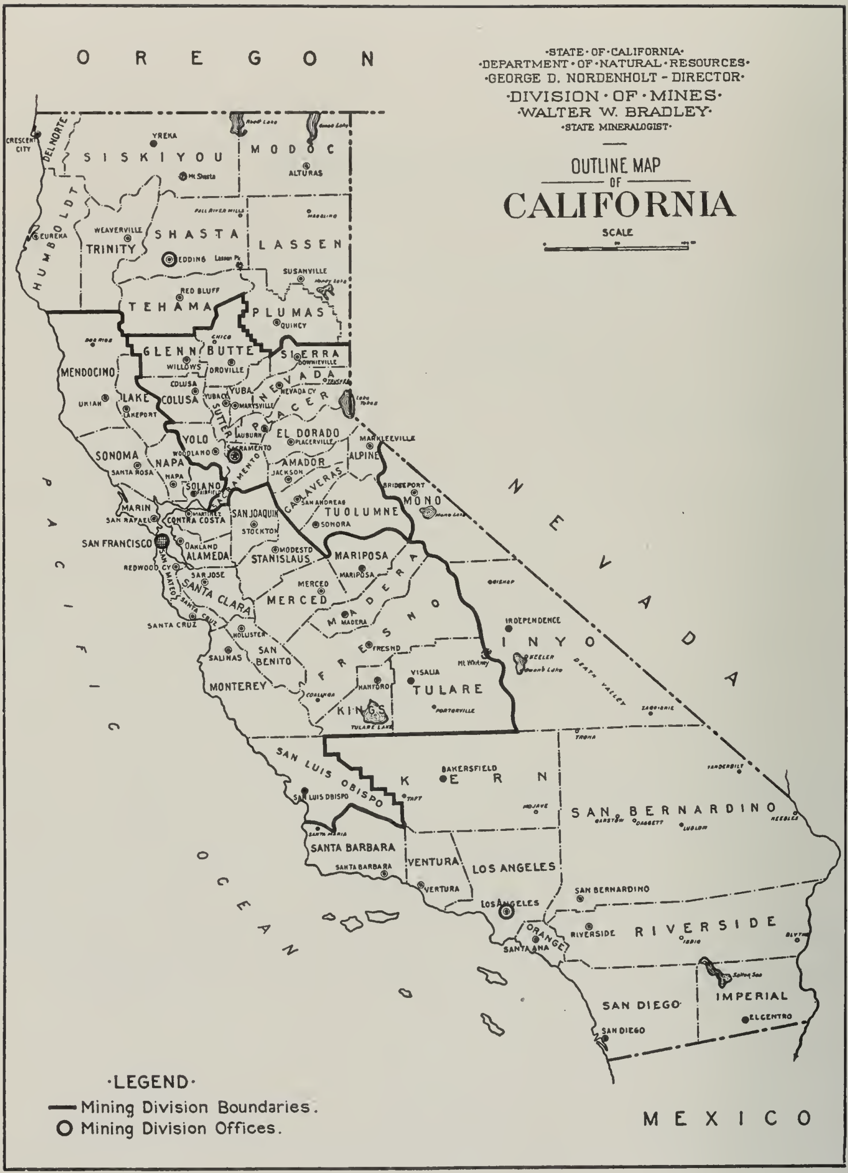
SPECIAL ARTICLES -- 471
  History of the Names Cobalt and Nickel, by W. B. Winston------------- 472
  Aluminum --- 475
  Quartz -- 478
  New Mining Laws -- 483

ADMINISTRATIVE -- 486

MINERALS AND STATISTICS --- 487
  Statistics --- 487
  Museum --- 487
  Laboratory -- 491

LIBRARY -- 492

PUBLICATIONS -- I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EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
Lassen Pk
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
MENDOCINO
UKIAH
GLENN
WILLOWS
BUTTE
CHICO
OROVILLE
SIERRA
DOWNIEVILLE
NEVADA
NEVADA CY
LAKE
LAKEPORT
COLUSA
YUBA
MARYSVILLE
SUTTER
PLACER
AUBURN
YOLO
WOODLAND
SACRAMENTO
EL DORADO
PLACERVILLE
SONOMA
SANTA ROSA
NAPA
SOLANO
FAIRFIELD
AMADOR
JACKSON
ALPINE
MARKLEEVILLE
MARIN
SAN RAFAEL
CONTRA COSTA
MARTINEZ
SAN JOAQUIN
STOCKTON
CALAVERAS
SAN ANDREAS
TUOLUMNE
SONORA
MONO
BRIDGEPORT
Mono Lake
SAN FRANCISCO
ALAMEDA
OAKLAND
SAN MATEO
REDWOOD CY
STANISLAUS
MODESTO
MARIPOSA
SANTA CLARA
SAN JOSE
SANTA CRUZ
MERCED
MADERA
HOLLISTER
SAN BENITO
SALINAS
MONTEREY
FRESNO
KINGS
HANFORD
Tulare Lake
TULARE
VISALIA
PORTERVILLE
Mt Whitney
INYO
INDEPENDENCE
BISHOP
KEELER
Owens Lake
DEATH VALLEY
SAN LUIS OBISPO
KERN
BAKERSFIELD
TAFT
MOJAVE
SAN BERNARDINO
BARSTOW
DAGGETT
LUDLOW
NEEDLES
VANDERBILT
SANTA BARBARA
SANTA MARIA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
INDIO
BLYTHE
ORANGE
SANTA ANA
SAN DIEGO
IMPERIAL
EL CENTRO
Salton Sea
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

J. C. O'Brien, Mining Engineer

There is no report from the Redding Field Division, on account of unfinished field work.

SAN FRANCISCO FIELD DISTRICT

C. McK. Laizure, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco Field District are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. Tucker and R. J. Sampson, Mining Engineers

On account of unfinished field work, there is no report from the Los Angeles Field District in this issue.

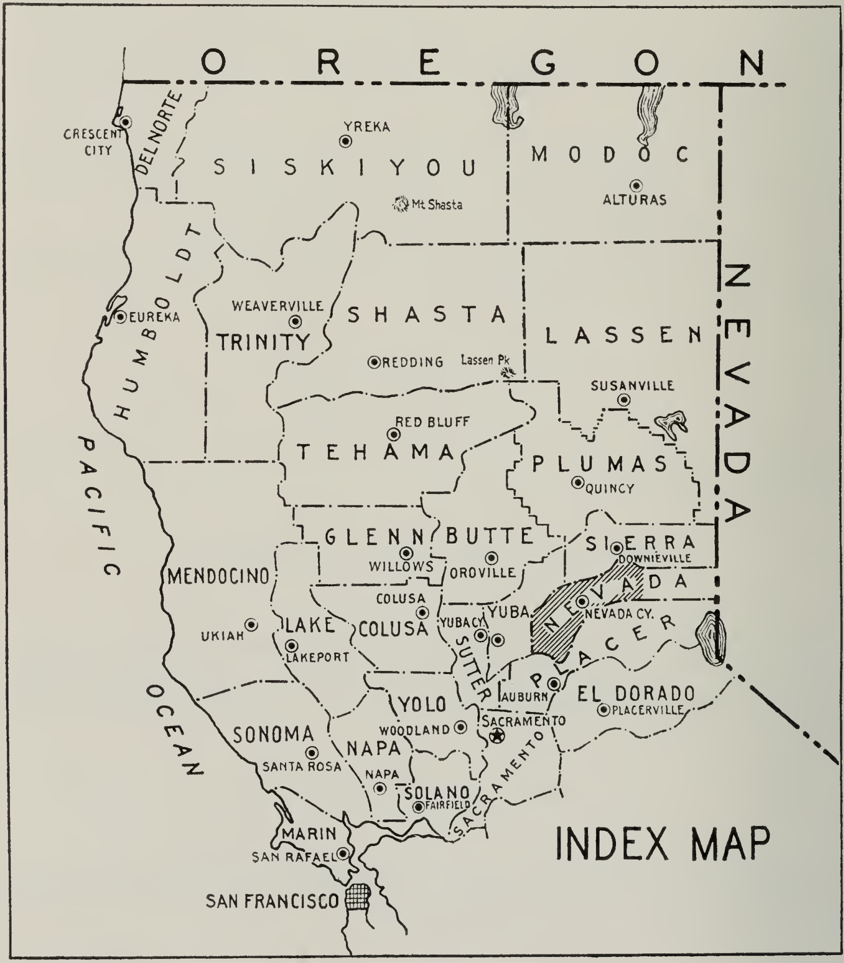
SACRAMENTO FIELD DISTRICT

C. A. Logan, Mining Engineer

MINERAL RESOURCES OF NEVADA COUNTY

GEOGRAPHY.

Though it owes its prominence first of all to its gold quartz and placer mines, this county shares with its neighbors in the fruit and livestock industries in the western foothill section, where the winters are mild. Grass Valley and Nevada City (the county seat) always supported by mining, are now almost one community because of the increase in population the past decade. Grass Valley now claims a population of 11,000. Both these places are at elevations of about 2500 ft. with a fine climate and little snow as a rule. They are 60 miles and 64 miles respectively from Sacramento on a lateral state highway which extends north and east through Sierra County.


OREGON
CRESCENT CITY
DEL NORTE
YREKA
SISKIYOU
MODOC
Mt Shasta
ALTURAS
HUMBOLDT
EUREKA
WEAVERVILLE
TRINITY
SHASTA
REDDING
Lassen Pk
LASSEN
NEVADA
SUSANVILLE
RED BLUFF
TEHAMA
PLUMAS
QUINCY
PACIFIC
GLENN
BUTTE
SIERRA
DOWNIEVILLE
WILLOWS
OROVILLE
MENDOCINO
NEVADA
COLUSA
YUBA
NEVADA CY.
UKIAH
LAKE
COLUSA
YUBA CY
SUTTER
LAKEPORT
PLACER
OCEAN
AUBURN
EL DORADO
YOLO
PLACERVILLE
SACRAMENTO
SONOMA
WOODLAND
NAPA
SANTA ROSA
NAPA
SOLANO
FAIRFIELD
SACRAMENTO
MARIN
SAN RAFAEL
SAN FRANCISCO
INDEX MAP

All the other active mining districts of the county are tributary to the above towns which serve as supply points for everything needed by the miner, including milling plants. A narrow gauge railroad connects with the Southern Pacific at Colfax, but passenger traffic is carried by automobile buses.

WATER, POWER AND TIMBER.

The extensive ditch system and the water supply impounded in many early-day mountain reservoirs for use in hydraulic mining have passed in large part into the hands of Nevada Irrigation District and Pacific Gas & Electric Company. Some of the mines still retain valuable water rights but in other cases the question of water supply will be a crucial one in determining the possibility of resuming hydraulic mining on a large scale. The supply for quartz milling is in general adequate in all parts of the county. Pine timber suitable for mine use is plentiful above 2500 ft. elevation. Electric power is supplied to the principal mining districts including Washington, by Pacific Gas & Electric Company.

MINERAL RESOURCES.

The gold quartz mines at Grass Valley have the largest production record of any in the state and the Empire has been in operation since 1850, longer than any other gold mine in the country. In spite of generally narrow veins and the high wage scale ($5.76 for miners and $5.24 for muckers per shift in 1940-1941) the margin of profit has generally been satisfactory. The gold resources amenable to hydraulic mining are also the greatest in the state. Silver, copper, lead and zinc are now produced only as by-products of gold quartz mining. Asbestos, barytes, chromite, mineral paint, manganese ore, pyrite and tungsten have all been produced in small tonnages.

GEOLOGY.

The geology of Nevada County mines has been described in great detail in both the past reports of this division, its predecessor, the State Mining Bureau, and in the publications of the U. S. Geological Survey. The reader is particularly referred to Waldemar Lindgren's exhaustive paper in Report XVII, part 2 and the fine report of W. D. Johnston, Jr., in Professional Paper 194, dated 1940, both published by the U. S. Geological Survey.

The present report is intended to bring up to date the more important results of mining in the county during the past decade since the 1930 report, and to add details concerning other mines not previously covered, even though some of these have been idle a long time. The author regrets that it is not possible to complete the report because of being called to other work.

ACKNOWLEDGMENT.

The uniform courtesy of mine owners and operating officials, and of the numerous mining engineers to whose reports special reference has been made, is gratefully acknowledged. Special thanks are due to John R. C. Mann, general manager, F. W. Nobs, vice president, and F. W. McQuiston, Jr., metallurgist of Empire Star Mines Company; Errol

MINERAL PRODUCTION OF

Year	Copper		Gold, value	Granite	
	Pounds	Value		Cubic feet	Value
1880			$2,702,362		
1881			3,700,000		
1882			3,500,000		
1883			3,000,000		
1884			2,950,000		
1885			2,577,873		
1886			3,221,038		
1887			2,719,574		
1888			2,600,000		
1889			2,249,335		
1890			1,969,613		
1891			2,207,886		
1892			1,945,406		
1893			2,067,203		
1894	83,728	$7,535	1,830,155		
1895	33,255	3,325	1,789,816		
1896	28,200	2,820	2,380,756		
1897			1,885,251	1,100	$2,200
1898	30,000	3,000	2,017,628	2,000	1,500
1899	43,438	7,084	2,171,510	2,000	1,500
1900	150,980	20,472	1,812,036		
1901	39,588	6,235	2,121,054		
1902	26,500	3,975	2,142,740	1,000	3,000
1903	4,500	585	2,458,047	2,170	4,160
1904			3,130,304	2,335	5,395
1905			3,179,715	2,155	2,570
1906			2,658,420	9,525	9,300
1907	22,082	4,418	2,162,083	12,840	9,300
1908	30,166	4,104	2,297,963	700	2,100
1909			2,660,235	1,250	2,800
1910			2,533,483	2,225	3,215
1911	1,665	209	2,199,147	1,250	3,500
1912			2,081,958		
1913			2,918,733		
1914	39	5	3,301,948		
1915	1,817	318	3,466,722		
1916	3,487	858	3,669,878	100	100
1917	40,165	10,965	3,682,947		
1918	42,203	10,424	3,070,453		
1919	(2)		2,981,312	(2)	
1920	(2)		2,872,471	(2)	
1921			2,570,162	(2)	
1922	(2)		2,903,573	(2)	
1923	(2)		2,282,155	(2)	
1924	(2)		2,820,032	(2)	
1925	(2)		2,305,607	(2)	
1926	(2)		2,318,846	(2)	
1927	(2)		2,127,195	(2)	
1928	(2)		1,994,002	(2)	
1929	5,702	1,004	1,807,613	(2)	
1930	17,009	2,211	2,193,486		
1931	143,984	13,103	3,304,815		
1932	33,454	2,108	3,640,797		
1933	67,179	4,299	4,676,357		
1934	113,771	9,101	7,118,551	(2)	
1935	201,890	16,757	8,785,099		
1936	149,673	13,770	9,897,265	(2)	
1937	178,643	21,616	10,805,200	(2)	
1938	124,058	12,158	11,261,530	(2)	
1939	27,113	2,820	11,155,655	(2)	
Totals	1,644,289	$185,279	$200,854,995	40,650	$50,640

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(1) Includes crushed rock, rubble, sand, gravel.
(2) See under "Unapportioned."

NEVADA COUNTY, 1880-1939

Lead		Silver, value	Miscellaneous stone[1], value	Miscellaneous and unapportioned		
Pounds	Value			Amount (tons)	Value	Substance
-----	-----	$70,144	-----	-----	-----	
-----	-----	9,500	-----	-----	-----	
-----	-----	10,000	-----	-----	-----	
-----	-----	8,000	-----	-----	-----	
-----	-----	5,000	-----	-----	-----	
-----	-----	4,835	-----	-----	-----	
-----	-----	8,333	-----	-----	-----	
-----	-----	2,477	-----	-----	-----	
-----	-----	5,000	-----	-----	-----	
-----	-----	5,633	-----	-----	-----	
-----	-----	14,713	-----	-----	-----	
-----	-----	14,184	-----	-----	-----	
-----	-----	8,326	-----	-----	-----	
-----	-----	1,229	-----	-----	-----	
-----	-----	476	-----	290	$5,800	Mineral paint.
-----	-----	400	-----	150	2,250	Mineral paint.
-----	-----	8,584	-----	-----	-----	
-----	-----	8,116	-----	-----	-----	
-----	-----	19,476	-----	50 6,000	1,000 30,000	Mineral paint. Pyrite.
-----	-----	17,784	-----	300 5,400	5,400 28,620	Mineral paint. Pyrite.
-----	-----	66,841	-----	2,925	17,550	Pyrite.
-----	-----	18,122	-----	78	429	Pyrite.
-----	-----	6,124	-----	-----	-----	
-----	-----	3,252	-----	-----	-----	
-----	-----	9,555	-----	-----	-----	
-----	-----	32,523	-----	-----	20	Platinum.
-----	-----	24,219	-----	-----	-----	
-----	-----	17,505	-----	-----	-----	
663	$25	21,914	$1,678	-----	-----	
-----	-----	24,926	1,874	-----	400,000	Unapportioned, 1900-1909.
-----	-----	16,506	-----	-----	-----	
14,831	667	15,691	-----	-----	-----	
1,785	80	22,830	-----	-----	-----	
2,090	92	26,542	5,000	-----	-----	
145	6	27,000	2,108	-----	60	Gems.
1,567	74	23,762	3,675	-----	1,950	Other minerals.
1,036	71	35,741	1,225	981 -----	12,795 23,475	Chromite. Manganese, platinum, tungsten.
(2)	-----	52,335	1,600	1,962 -----	43,449 47,101	Chromite. Asbestos, lead, platinum, tungsten concentrates.
(2)	-----	72,557	1,400	3,328 -----	116,993 29,884	Chromite. Asbestos, lead, manganese, platinum, tungsten concentrates.
(2)	-----	68,731	1,976	-----	12,034	Asbestos, barytes, chromite, copper, granite, lead, platinum.
(2)	-----	58,476	6,528	-----	17,531	Asbestos, barytes, copper, granite, lead.
-----	-----	33,906	19,151	-----	17,862	Asbestos, barytes, granite.
(2)	-----	19,583	27,982	-----	14,867	Barytes, copper, granite, lead, mineral paint.
1,290	90	30,534	42,309	-----	15,682	Asbestos, barytes, copper, granite, mineral paint, platinum.
(2)	-----	39,252	82,200	-----	3,783	Copper, granite, lead.
(2)	-----	32,155	10,333	-----	4,782	Chromite, copper, granite, lead.
4,301	344	30,015	850,000	-----	41,006	Barytes, copper, granite.
(2)	-----	27,581	15,000	-----	43,933	Barytes, copper, granite, lead.
(2)	-----	20,798	4,000	-----	5,086	Copper, granite, lead.
6,603	416	21,861	83,770	-----	65,364	Baryte and granite.
18,164	908	23,316	76,850	-----	23,462	Baryte and platinum.
198,671	7,351	43,611	123,024	149,865 lbs.	5,314	Zinc.
82,119	2,464	29,868	24,866	-----	4,000	Other minerals.
72,380	2,678	56,109	24,400	34,478 lbs. -----	1,448 2,100	Zinc. Other minerals.
130,301	4,821	203,190	151,032	-----	2,300	Other minerals.
355,526	14,221	374,010	2,661	-----	2,400	
307,272	14,134	352,665	41,205	-----	3,656	Include granite, platinum.
316,006	18,644	391,502	144,300	-----	3,794	Include granite, platinum, mineral paint.
286,006	13,174	326,565	44,758	-----	9,711	Include granite, platinum, barite.
39,921	1,876	278,864	21,446	-----	7,895	Include granite, platinum, barite.
1,841,127	$82,136	$3,202,747	$1,816,351	-----	$1,500,726	

MacBoyle, executive vice president, Albert Crase, general manager, and Hugh M. Wolflin, assistant manager, Idaho Maryland Mines Corporation; Otto Schiffner, general manager, and John Chandler, general superintendent, Lava Cap Gold Mining Corporation; and Arthur B. Foote, formerly general manager, North Star Mines Company.

ASBESTOS

Rolph Ranch. A prospect of chrysotile asbestos on this land near Chicago Park has been slightly prospected but no production has been reported.

Sierra Asbestos Co. This company lapsed or was suspended in 1935, the last known address being 214 Hillside Avenue, Piedmont, California. The property is 2½ miles by road northwest of Washington and 21 miles from Nevada City. Small tonnages were milled between 1917 and 1923. The product was short fiber chrysotile asbestos, obtained by milling serpentine carrying a network of asbestos veinlets. Only a little of the asbestos was an inch or more in length. Mining was done in an open pit. At first an old 20-stamp quartz mill, fitted with air suction and fiberizing machinery, was used. Later 42-inch rolls were installed, but no regular production was made. No recent activity has been noted. At present the claims are reported to belong to Dr. J. H. Stark, Oakland.

Only assessment work was done in 1940.

BARITE

Barium sulphate occurs at several places in the county but the most important deposits have been found at Democrat and the Spanish Mine property.

Democrat Barite Mine is in sec. 24, T. 16 N., R. 10 E. Between 1919 and 1930 it was an important producer, and during most of that time was the largest source of barite in the state. Nothing has been done for several years. The orebody was 250 ft. long near the surface and from 15 ft. to 24 ft. wide. The deepest working was called the 100-ft. level, and was an adit. A tramway 1800 ft. long was used to transport ore across the deep canyon of Bear River, and it was hauled thence about 6 miles to Alta, the railroad shipping point. Owner: Chemical & Pigments Company, Inc., Oakland.

Spanish Barite Deposit (see Spanish Mine, under Gold) is five miles by road west of Graniteville in the NW. ¼ of sec. 19, T. 18 N., R. 11 E. Barite outcrops along the old North Bloomfield ditch, at an elevation of 4600 ft. and for a length of 330 ft. The color of the freshly broken rock is white to creamy white, and the quality of ore at the outcrop appeared good, except that the joints and bedding planes are coated with bright red layers of iron oxide, sometimes over ⅛ inch thick.

Prospecting done by the owners has developed a deposit which they claim contains several hundred thousand tons of the barite. A crosscut 280 ft. vertically below the outcrop failed to show the ore, but a raise 400 ft. long on the dip from this crosscut to the surface is reported to show barite the entire distance, having a thickness of 15 ft. in places.

Stripping has shown the deposit extends farther than shown by the outcrop.

In 1939 some of this barite was hauled to Emigrant Gap for shipment. This is a trip of 20 miles involving a descent of 1800 ft. to Washington, a climb of 1500 ft. in 4 miles, and another climb out of Bear Valley. Late in 1940 work was resumed on the property. They are engaged in filling an order for 1500 tons.

CHROMITE

Over 6000 tons of this ore and concentrate was produced in the county from 1916 to 1919. The deposits were described in the report for 1918 and in Bulletin 76, 'Manganese and Chromium in California.' Many of the deposits contained low-grade ore and two stamp mills at Nevada City were utilized for crushing this ore for concentration. The grade of concentrate made on Johnson, Deister and Union concentrators was low, running in most cases from 32% to 36% Cr_2O_3. The grade obtainable was limited by the high iron-oxide content of the ore.

The larger producers were properties near the Champion Mine, just outside Nevada City, which supplied ores for the mills mentioned, and the Red Ledge Mine, near Washington, where ore carrying 42% to 45% Cr_2O_3 was produced.

Since the beginning of the present European war, interest in chromite has revived and there have been many inquiries about deposits. So far as observed during field work in the county in June and July, 1940, these had not resulted in any actual production, but owners of unpatented claims were doing assessment work to maintain their titles. Profitable marketing of domestic chromite depends upon the suspension of foreign imports and the depletion of stocks on hand. While it is too early to make any sweeping statements about the possible effect of another German submarine campaign against shipping, it is known ocean freight rates are rising. The accumulation of government stockpiles and of private stocks of ore that has been going on for months, and the tendency of government to curb profits in war materials, all favor the belief that prices for chromite (and manganese) ores will not reach the points reached in 1917-1918. Chromite is used for war purposes in steel furnace linings and to make ferro-chrome which is added to steel in making armor plate. The markets and the facilities for making ferro-chrome are principally on or near the Atlantic seaboard. Railroad freight rates from California are too high to permit competition with cheap ocean-borne foreign ore. The U. S. Government specifications for ore to make stockpiles are also too high to permit marketing much of the California ore, unless specifications are broadened to permit selling concentrate or artificial lump chromite made from concentrate.

COPPER

Although copper was discovered at Spenceville in the early 1860's during the first copper mining 'boom' in the state, the recent small copper production in Nevada County has been mainly as a by-product incidental to gold-quartz mining. The Boss Mine near North San Juan has been the only one recently operated where the ore contains an important amount of copper. Some of the ore at the Spanish Mine near Washington carries 0.6% copper and each of the other larger gold quartz mines report a few thousand pounds of copper produced yearly.

The most important producer has been the Spenceville Copper Mine, which from 1875 to 1887 produced 150,000 tons of a reported average of 5% copper. This was recovered by heap roasting, leaching and precipitation on scrap iron. This and many others have been described in past reports, particularly in Bulletin 50 of the State Mining Bureau.

GARNET

Brown garnet occurs in the region about 10 miles southwest of Grass Valley near Clear Creek. There has been nothing but the most superficial prospecting done on the outcrops which appear on ranches owned by C. H. Elster in sec. 30, T. 15 N., R. 8 E. and by W. B. Smith about 3 miles from Elster's place.

GOLD QUARTZ MINING

The gold-quartz mines of Nevada County, active since 1850, have kept that county at or near the top as a gold producer. Since 1929 when a gold mining revival started, this county has been in the lead. In 1937 the production reached $10,805,200, the largest in quantity and value up to that time, and sufficient to give the county seventh place in value of mineral output among all those in the state. The output in 1938 and 1939 exceeded $11,000,000 annually.

Since 1930, the monthly total of the mining payrolls of Nevada County has increased nearly $100,000, amounting to about $375,000 a month in 1940, or at the rate of about $4,500,000 a year. About 2500 men are employed and receive in wages about 40% of the sale price of all the gold produced, supporting directly and indirectly practically all the people of the county. The expanded activity has principally benefitted Grass Valley and Nevada City, both of which have increased greatly in population during the last decade.

If past experience is a safe criterion, it may be said that labor costs are from 60% to 65% of the total cost of mining and this would indicate that the gold mining companies in the county are spending annually from $7,000,000 to $7,500,000.

The two most important groups of gold quartz mines in the state are those operated by Empire Star Mines Company (Empire, North Star and Pennsylvania mines at Grass Valley; Murchie at Nevada City and Zeibright at Bear Valley near Emigrant Gap) and the Idaho-Maryland Mines Company (Idaho, New Brunswick and Bullion mines, all at Grass Valley). The quartz mines of the county produced nearly a million tons of ore in 1936, and in 1937 the output was 1,071,464 tons, most of which came from Grass Valley and Nevada City mines. The ore in several of the important mines of the district has been yielding from $10.50 to $13 a ton the past few years.

Alaska Mine. Lot 49, patented, 8.28 acres adjoins the Bullion Mines' Union Jack claim on the south, in SW¼ Sec. 1, T. 15 N., R. 8 E., 2½ miles southeast of Grass Valley. Lot 61, Ben Franklin claim 14.3 acres patented, adjoins the Alaska on the east.

The old Alaska shaft was vertical for 100 ft. and then followed the vein for 400 ft. The vein strikes north and dips 45° E. Old records indicate that its width where previously worked was from 8 inches to

3 ft. Work done in 1877 resulted in the production of ore yielding from $50 to $94 a load (a load contained about 1 ton). In 1878, the yield varied from $15 a ton to over $100 a ton exclusive of sulphides. The lots of ore milled were small, amounting in all to a few hundred tons. A length of 586 ft. was drifted southward from the 140-ft. level; shorter drifts were run on the 220-ft.; 275-ft. and 340-ft. levels. This vein is in the granodiorite.

The Alaska was not listed among the producers again for many years. In 1924 Ben Hur Divide Mining Company began work on the Alaska and the Ben Franklin. About 100 tons of ore in all was milled, partly from the 400-ft. level of the Alaska. This work stopped in 1926. In 1935, the operators of the nearby Bullion Mine took over the Alaska. A new shaft was sunk to 500 feet and in 1937 ore was being mined at the rate of 25 tons a day and was being hauled to the Idaho Maryland mill.

Alcalde (Bowery, Seven Thirty or Kenosha) Mine. This old group of 12 claims (unpatented) is 4 miles southwest of Grass Valley in secs. 5 and 6, T. 15 N., R. 8 E., in Deadman's Flat district. Their history was given in some detail in our 1918 and 1930 reports.

The district has been known principally for small 'specimen' ore discoveries and the production from the Alcalde has been of this nature. The principal vein fills a fissure in amphibolite, the quartz averaging 6 inches wide in a 'formation' from 18 inches to 2 ft. wide. The strike is N. 17° W. and dip 45° to 75° W. ''Iron crossings,'' a miners term for zones in the amphibolite which are higher in iron sulphide content than the average rock, and which cross the vein, have been regarded as responsible for the specimen ore.

Contemporary news items about the old operations of these claims give an idea of the results obtained.

August 8, 1868: 22 loads of ore from the Seven-Thirty gave over $1100.

July 31, 1870: On Monday, gold valued at $1500 including 2 specimens, not as large as a man's fist (value $700). Since Monday, yielded over $5000.

July 22, 1871: 21 loads crushed, gave $4410, or $210 a load.

The Bowery was an extension of the Seven-Thirty, the old shafts being only 550 ft. apart. On Jan. 1, 1869 a news item stated that 16 loads (of about 1 ton of ore each) had yielded $2541, or $158.81 a load.

After the 1930 report the claims lay idle and were in litigation some time. In 1933, work was resumed on a new shaft 750 ft. from the old Alcalde shaft, which had been used in later years. This new work was done by Mattie Gold Mining Co. They had 2200 acres under option, including the Alcalde, Normandy, California, South Star and Standard groups of claims. They changed the name Alcalde to Mattie. The 3-compartment shaft 5 ft. by 14 ft. in the clear, was sunk on an incline of 70° to a depth of 735 ft. Late in June 1935, work was stopped and the pumps were pulled, with no record of new production. In May, 1937, C. L. Best began unwatering the shaft. Within 3 months the mine was closed down again.

Allison Ranch Mine. The former operation of this old property has been described in our past reports (XI, XIII, 1918, XVII, XXVI). Nothing came of the proposed stock company mentioned in Report

XXVI, and no new underground work has been done. In 1933 a contract was let for dismantling the mine buildings and headframe. In 1935 a Huntington mill was erected to work the old dumps, which were sorted.

Melville Attwood, writing in the Eighth Report of the State Mineralogist stated that he thought

> "the richest croppings above the water line met with and treated in quantity in the Grass Valley district was from the Allison Ranch Mine in 1855. Twenty-one tons milled at the Gold Hill mill (operated by Attwood) yielded at the rate of $370 a ton."

The production record of this mine is as follows:

From December, 1854 (discovery), to October, 1866 (depth 475 ft.), 46,000 tons	$2,300,000
From April, 1869, to December, 1871 (to 600 ft. depth)	200,000
From 1896 to March, 1903 (1675 ft. deep,, 1400 ft. length)	40,600
From 1918 to 1921, incl. (upper levels and Cariboo vein), 43,000 tons	224,000
Total	$2,764,600

Dividends of $1,200,000 were reported from the first 46,000 tons of ore.

Allison Ranch Ford Claim. This is the second claim north of Allison Ranch Mine. The Horseshoe shaft was sunk 240 ft. deep in early days on the vein traversing this claim on the west side of Wolf Creek and about 3500 ft. north of Allison Ranch shaft. Between them is the Franklin (now called the Allison Ranch Franklin) also worked in early days and equipped then with a mill.

Amador Consolidated Claims. These lie south of the Belle Union and east of the Norambagua. The two patented claims, Amanda and Amador, cover 2495 ft. on the strike. They were located in 1872 by John G. Johnson. About 1902 he started a shaft on an incline of 45° on the south end of the Amador (southerly) claim. This was sunk on the vein to an inclined depth of 250 ft. An adit was also run 600 ft. of which 400 ft. is said to be on the vein. The shaft is caved near the top but is well timbered from the adit level down. The vein has a thickness of 3 ft. to 4 ft. of ribbon ore which the owner says would mill from $6 to $15 a ton (old gold price). The mine was worked then by lessees and tributers.

In 1922, Edgar F. Johnson found a good prospect on the north end of Amador claim on the main vein at a crossing and sank a shaft 75 feet deep there. The vein is 18 inches thick here and panned well. At a point 100 ft. or more down the hill from this shaft, Johnson and lessees sank an inclined shaft 150 ft. to cut the main vein. In this they cut another vein 11 inches thick which was followed in the shaft close to its junction with the main vein. It also is said to prospect well. Work was stopped because of lack of funds. The owner has records of good assays.

Scheelite occurs in the ore on the dump at the 250-ft. shaft but went unnoticed until seen by Fred M. Miller recently.

Electric power is within ¾ mile, and water is available at two places on the Amador claim. There is a road to the claims and some timber upon them.

Ancho and Erie Groups.

Ancho Mine, 2 miles south of Graniteville, has been active intermittently since the 1930 report. In 1932, West Mines Corporation consolidated the Ancho and Erie Groups of claims. The Ancho group consists of the Ancho Q. M. and mill site, Edison Q. M. and mineral survey 5968, (West Virginia, Ohio, Wheeling and Nevada patented claims, 60.036 acres) a total of 80.086 acres. The Erie group comprises the Wheeling Lode and mill-site, Holland Q. M. and millsite, Dublin Bay Cons. Q. M., Erie Q. M. and mill-site, Canton, Cascaret, Danderine, Erie Holland No. 2, Lane and Neuralgia Lode Mining claims, and Cascaret mill site, over 234 acres in all. The holdings form a group around the corner common to secs. 16, 17, 20 and 21, T. 18 N., R. 11 E., but are chiefly in the W. ½ sec. 21, T. 18 N., R. 11 E.

The Ancho veins on the north and those on the Erie claims to the south, are in the Mississippian marine meta-sediments locally called the Blue Canyon formation (Carboniferous) about ½ mile west of their contact with a granite area which extends across the county from north to south and has a width of as much as 5 miles but is partly covered by morainal material on the east. Of the 4 veins on the Ancho claims, three average about 4 ft. wide and one, the Wheeling, has a width of 50 ft. of quartz and slate. Most of the development has been upon the Ancho vein. The veins strike a little west of north and dip 60° to 70° E. Ore milled previous to 1930 yielded from $3 to $6 a ton, but work was irregular.

The principal veins on the Erie claims strike north; Erie vein dips 70° E. and Dublin Bay vein 45° E. The Erie vein is said to have contained an ore shoot 400 ft. long and from 5 ft. to 30 ft. wide. Two ore shoots in the Dublin Bay were 70 ft. and 100 ft. long and from 12 ft. to 15 ft. wide. In 1910 and 1911 the Erie claims produced considerable material of low grade. In 1914 and 1915 a much smaller tonnage of profitable ore yielded from $6 to $10 a ton, the latter being relatively high grade for this district. The Erie has not been productive since that time. The Ancho, however, had an output of 6409 tons in 1934 and a small yield in 1935.

The present lessees, Gus Helback, Fred Anderson and Earl Raymond took a lease and option on the property in February, 1939, and work has been going on since. This has been devoted to preparations for reclaiming an old stope in No. 3 tunnel where 3000 tons or more of ore is believed to remain, and a pillar also claimed to contain 4000 tons of ore. This ore is said to assay $5 or more a ton. A new adit, intended to cut the Ancho orebody 404 ft. vertically below the No. 3 level (470 ft. deeper on the dip) has been run 200 ft. (May, 1940). If this adit is completed the entire distance of 2200 ft. to the Ancho vein, it should cut the Dublin Bay vein and Wheeling vein also on the way.

Andy Fitz Mining and Milling Company, 1540 San Pablo Ave., Oakland, has 9 full-sized lode claims in the Moore's Flat district, Nevada County, and the adjoining southern part of the Alleghany district, Sierra County. Of a total of 4500 ft. along the lode line, 3000 ft. lies in Sierra County and 1500 ft. in Nevada County. The claims are reached by road to Orleans, thence a mile and a half trail to the mine.

The country rock is amphibolite schist, believed to be derived from gabbro, with several narrow, lenticular bodies of serpentine. The development work consists of an adit about 1400 ft. long, 6 ft. by 8 ft. in cross section with raises at points 150 ft., 450 ft., 510 ft., and 682 ft. from the portal, 2 crosscuts to the hanging wall and 2 to the footwall. The adit follows the vein which strikes northwest and dips about 45° E. The only timbering was a little near the adit portal. The vein is lenticular with a reported average thickness of 4 ft. and a maximum of 9 ft. Bodies of ''talc'' are reported at intervals and ''bluejay,'' the characteristic carbonate rock colored by green mariposite, was found in the hanging-wall crosscut at the 680-ft. point. Four lenses of quartz have been found, but so far no ore has been stoped and assays were not supplied by the company in response to inquiries.

Buildings include 5-room bunk house and kitchen, blacksmith shop, compressor house and small powder house. Equipment consists of 10 in. by 12 in. compressor, Pelton water wheel, cars, track and hand tools. The Middle Fork of Yuba River flows through the property close to the camp.

Arctic Mine. This group was described in the 1918 report, and a map and section were shown in the 1930 report. Little mining was done between 1930 and 1937. Disputes and litigation over water rights resulted in limiting the operation of the fine hydro-electric power plant in recent years to the period between January and June when there is surplus water in Canyon Creek. The mine is 25 miles east of Nevada City and 7 miles from Washington and has considerable snow in winter as the elevation ranges from 3600 ft. to 5267 ft. at Arctic Point.

November 1, 1937, L. F. Utter and associates took the property over and started work. The first milling was done in June, 1938 using hydro-electric power for a short run. The mill was again operated during the water seasons in 1939 and 1940.

An adit has been run 620 ft. nearly north from the south end of Cosmopolitan claim near Canyon Creek to develop and exploit a vein with a reported average width of 3 ft. which strikes north and dips west. Seven stopes have been opened of which 3 are said to have yielded the best ore.

The reduction plant contains an Eimco 5 ft. by 5 ft. ball mill, classifier, jig, 4 Kraut flotation cells and Denver sub-A cell. Ore is said to range from \$6 to \$12 a ton and recovery is reported to be very good. The mill is now operated by Diesel engine during the summer and fall period of water shortage, but water power is always available for the compressor.

Good prospects are also reported in a 4-ft. vein on the Washington claim just north of Canyon Creek, where there is an 80-ft. shaft. The Arctic vein, toward which the main crosscut was run years ago from Canyon Creek for 950 ft., is said to show a width of 4½ ft. and assays of \$8.00 a ton where it was cut near the face. There are backs on this vein of over 800 ft. above this adit, with a vertical distance of over 600 ft. to Arctic No. 2 adit. Four other veins were crossed in the main adit before reaching the Arctic vein.

All the veins on these claims are in granite and are part of the system worked at the Eagle Bird and Ethel mines in years past.

In September, 1940 L. F. Utter turned his interests over to Jack Warner, Reno, Nevada, and he in turn transferred his rights to George Burr also of Reno. In December, 1940 a crew of 24 men were employed and 45 tons of ore was being handled daily, according to a statement by Utter.

Belle of France claim is in the SW. ¼, sec. 3, T. 15 N., R. 8 E. Although considerable work has been done upon it, it has not been mentioned in previous reports. In 1894 it had tunnels, crosscuts and shafts that had been run to prospect 2 veins 15 ft. apart. It was reported several loads of ore had been milled. That from a vein 7 ft. wide yielded $5.50 free gold and an 8-ft. vein returned $6.50 free gold a ton. The sulphides from this ore is said to assay $255 a ton. Forty feet west another wide vein outcrops along the contact of slate and granodiorite. Again in 1895, the lower adit was reclaimed. Ore was reported 405 ft. from the mouth and 200 ft. vertically below the surface in a vein 20 ft. wide.

Bellefontaine Mine (once called the Ebaugh) 2¼ miles east of Nevada City, was found in 1858 and was known as a producer of small lots of rich ore. Up to June 1895, according to Mining and Scientific Press, $30,000 had been produced from shafts, and the ore yielded from $24 to $117 a ton. The vein which has an actual strike of East to Northeast, dips north 20° to 30° and varies in width from 4 inches to 2 ft., occurring in granodiorite on the slope adjoining Deer Creek. This permitted working through a series of adits and inclined shafts. The lowest adit, 10 ft. above Deer Creek, gave backs of about 600 ft. on the dip. An ore shoot 210 ft. long and 2 ft. wide was reported.[1] A streak of sulphides 2 inches thick on the footwall was said to assay $252. A winze was sunk below the adit and production continued until 1916. Most of the ore mined between 1907 and 1916 ranged from $5 to $25 a ton, but some of it paid $150 a ton.

The Bellefontaine, Lecompton, St. Louis, Federal Loan, Posey, Jackson, Norton and Independence quartz mines and other land between the Hoge and Murchie were taken under option in December, 1938 and June, 1939 by *Valley Gold Mines, Inc.* Their plans were interrupted by the death of Thomas F. Cole. In June, 1940 assessment work was being done on some of the unpatented ground.

Ben Franklin Mine. Work had already reached a depth of 100 ft. on the vein early in 1869 when the first results of milling were released. In that year the thickness of the vein varied from 6 inches to 4 ft., the average yield was about $40 a ton and the total output for the year ended July 1, 1869 was $12,118. Work continued in a small way, off and on, for years. In 1872 less than 50 tons of ore yielded $2400. In 1893, a lot of 12 loads (about 1 ton each) yielded $33 a load, with the vein 10 inches thick. In 1909, with a vein 14 inches thick, the average yield was $16 a ton.

In later years the claim was grouped with others including the St. Stephens and patented. These and the Alaska were leased by the same people and a little production was reported between 1912 and 1917. The recovery per ton during this time varied from $1 to $35, the total output being about 1000 tons. In 1924 Ben Hur Divide Mining Company took a lease and option on the group, including the Alaska (which see). Work stopped late in 1926. In 1928 the 10-stamp mill was sold and moved to the Gracie.

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[1] State Min. Bur. R. XIII, p. 235.

Birchville Mine. This mine, later patented as part of the Iowa Consolidated (95.56 acres), lies 2 miles southeast of Graniteville. It had a 10-stamp mill in 1870, when the ore was said to have paid $15 to $40 a ton. For a description of the workings, see the 1918 report. The 2 principal veins are the Birchville, striking northeast and dipping southeast, and the Commercial, striking N. 5° E. and dipping 35° to 65° E. There is a shaft 400 ft. deep on the Birchville vein with levels at 200, 300 and 400 ft. The longest is the 300-ft. level, drifted 450 ft. north and 300 ft. south. From the 200-ft. level a crosscut was run 1600 ft. to the Commercial lode with drifts 250 ft. north and 250 ft. south and raises 106 ft., 120 ft., and 130 ft. on that vein.

An ore shoot was stoped from the 400-ft. to 200-ft. level north of the shaft on the Birchville vein, which shows a reported width of 1 ft. to 5 ft. in lenses. Between 1908 and 1914 inclusive, Birchville Mining Company produced and milled nearly 10,000 tons of ore, which gave an average recovery of $5.50 a ton (old gold price). The ore was worked in 2 Straub mills. Concentrate was apparently very small in amount and of nearly negligible gold content, judging by results mentioned. Both walls of this vein are granite.

In June 1940, Mr. Milicheck was putting up a new headframe at the mine.

Black Bear Mine (Forlorn Hope). On Deer Creek, 2½ miles from Rough and Ready. It has been worked in a small way and irregularly for many years, being mentioned in 1893 as yielding $4.50 a ton, but not appearing in the list of producers. In 1896 it had 3 adits from the lowest of which, near the creek level and over 400 ft. long, a winze had been sunk 200 ft. below the adit at a distance of 225 ft. from the portal. There was a 5-stamp mill on the property at that time. Though credited in local news items in September, 1910, as producing $5,000 it is not listed officially as a producer that year. In 1911 it produced 2000 tons of $5 ore and from 1914 to 1917 inclusive is said to have yielded about 2300 tons which gave a recovery ranging from $2 to $10 a ton.

Between 1918 and 1929 the mine was leased by several stock companies, including *Rand Divide Mining Company* and *West Empire Mining Company* but none of them made any production. Since 1929 it has been controlled by Cooley Butler, operator of the Golden Center Mine. He has been advancing the tunnel recently with a small crew. Some ore from the footwall side of a vein 22 ft. wide gave encouraging results.

Boss (San Juan) Mine, 40.63 acres patented, covers over ½ mile along the township line between secs. 1 and 12 T. 17 N., R. 7 E. and secs. 6 and 7, T. 17 N., R. 8 E. It is in amphibolite schist near the contact with granodiorite. Like so many of the small mines in the foothill copper belt, the gossan was worked for gold 40 years ago, having a vertical shaft that reached a depth of 250 ft. Oxidation reached a depth of about 100 ft. below which the mineralized schist contained pyrite and chalcopyrite, with some gold, silver and zinc.

The mine lay idle in late years until 1930 when reopening was started by the Bradley interests. They first cleaned out the shaft to the 200-ft. level and drifted north 700 ft. Later some sinking was done, and shipments of ore were made to Tacoma smelter between 1933 and 1937. A number of claims were located contiguous to the patented land, and trenching and diamond drilling was carried on.

Boundary Mine (Grass Valley Boundary Mines). This is in the western part of the town of Grass Valley and contains about 30 acres, including the New Idea, Oak Tree Quartz and Oak Tree Mine, as well as mineral rights under some town lots. The property was sold to John N. Becker by Grass Valley Boundary Mines Company according to a deed recorded in October, 1939. Since that time Becker has resumed sinking the shaft, which was previously 328 ft. deep, and had reached a depth of 720 ft. in January, 1941. There is an old mill of 5 stamps, which was put up in 1920. A rather heavy flow of water was struck in January, reported to amount to 400 g.p.m. or more.

The geology of this property has been described by W. D. Johnston, Jr. in Professional Paper 194 of the U. S. Geological Survey.

Brackett Lode. This is 1½ miles southeast of Nevada City, and contains 15.953 acres. The work done upon it has been principally that required for patent. The owner states that a vein about 5 ft. wide gives assay value of $3.15 a ton (old gold price). There are 3 old opencuts on the claim.

Buena Vista Claim. This adjoins the Allison Ranch Mine on the south. It was located and patented years ago by S. P. Dorsey, father of the present owner, to cover the presumed southward extension of the Allison Ranch vein. Although the latter vein was not traceable on the surface in the Allison Ranch Mine, it paid well underground and the Buena Vista claim was taken with the idea that the rich shoot might pitch southward under this ground. Shallow shafts and prospect holes made to satisfy patent requirements expose a vein dipping west and striking north. No work has been done in recent years.

Bullion Mine. Grass Valley Bullion Mines, Inc. have been operating the property recently but Idaho Maryland Mines Corporation holds a deed of trust on all the property for advances made and has purchased a large part of both Class A and Class B stock. In secs. 1, 2, T. 15 N., R. 8 E., on state highway 2 miles south of Grass Valley.

The holdings comprise the Bullion, La Bruja, Union Jack and Smuggler mines and 40 acres of agricultural land. The operations previous to 1918 were described in our report of that year. The main inclined shaft was started in the hanging wall, and struck the vein at 300 ft., then followed the vein on its dip 25° E. to an inclined depth of 1500 ft. Later winze workings have gone 1200 ft. deeper on the dip, to 2700 ft. (incline).

The flat-dipping vein brought the operators into conflict with Empire Star Mines Company and that company obtained a court judgment against the operators of the Bullion mine for ore adjudged to belong to the former.

Production of ore has been going on since August, 1934. Ore has been treated at the plant of Idaho Maryland Mines Corporation. Production recently has been at the rate of about 25,000 tons annually. A crew of 44 men is employed.

California Consolidated (including the *Gold Tunnel*). The Gold Tunnel Mine was the first quartz mine located in the Nevada City district (1850) and the only one which survived the first slump. It is on the west side of the town, and north of Deer Creek. J. Ross Browne states in his report for 1868 that between 1852 and 1855 it was worked by E. W. Kidd and produced $300,000, the yield being $50 a ton. It was worked through a tunnel running north from Deer Creek, and a continuous orebody 600 ft. long was reported. In 1855 it was sold to men who operated it 8 years; and other parties worked it most of the time until 1875. In 1877, 1880 and 1891 small lots of ore paying from $15 to $23 a ton were produced. In 1892, a lot of 16 tons yielded $60 a ton. No complete record of the mine's output is available but it was the most important of the 4 worked on the 6500 ft. or more of this vein. In the Gold Tunnel, the vein was said by Lindgren to average 14 inches in thickness. On this property it strikes nearly north and dips 30° E. The country rock is granodiorite. Below the oxidized zone in which the rich ore was found, the vein carries 2% of sulphides. The mine was worked from 1895 to the end of 1897 and possibly later, and more ore was milled but the results are not available. In 1897 it was reported that $15 ore 18 inches thick was found after running a tunnel 500 ft. The old workings, including 2 shafts, reached an inclined depth of 360 feet below the tunnel, with 2 lower levels, the deepest 250 ft. below the tunnel.

The *California* claim, on the same vein on the south side of the creek was worked from 1857 to 1868 and is said to have produced $90,000 in 1875.[1] As a sample of the grade of this ore it was stated that [2] 300 tons produced $6656 in amalgam and $1500 in concentrate or over $27 a ton. The vein at that time was from 1 ft. to 2 ft. wide. It was active also in the 1890's, but no full account of output is available. The California was worked by adits and a shaft to a depth of 700 ft., with 3 levels below the adit.

Canada Hill Mine is in sec. 17, T. 16 N., R. 9 E., 2 miles east of Nevada City. Claims in the group are: Canada Hill, Charronnat-Lindley, North Grant, Alpine, Independence, St. Louis, and Little Done, a total of 164 acres.

The first quartz mining was done on the Canada Hill vein in a series of shallow shafts, followed in 1864 by the sinking of the Canada Hill shaft 250 ft. and mining to that depth. Up to 1879 no definite record of production was preserved, but the ore is said to have yielded $50 a ton. From 1879 to 1886 the mine was worked by the Charronnat family who produced $329,667 [3] from 19,104 tons, with an average recovery of $17.25 a ton. Since 1886 the property has belonged to the Gaylord family. It was worked again between 1904 and 1910, during which a production of about $300,000 from 20,000 tons of ore is claimed. All ore in sight had been mined by 1910, and the claims lay idle thereafter until April, 1933, when West Mines Corporation began reclaiming the workings. After clearing caved ground for the first 250 ft. they reopened the shaft to the bottom (1508 ft. on the vein, with an inclination of 15° to 20°). Twenty levels had been opened by the previous operators, who had mined an ore shoot 350 ft. in length in a block of ground bounded by cross faults. West Mines Corporation did 124 ft. of development work on No. 9 level south, 420 ft. on No. 19 level north and 40 ft. on No. 18 level south, besides opening the old drifts on these levels, amounting to 1000 ft. No. 9 level south finally had 559 ft. of work, and No. 19 level north, 770 ft., including a 40-ft. raise. Their work ended in August, 1934, after a little ore had been mined by lessees.[1]

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[1] Raymond, R. W. Mineral Resources of U. S., West of the Rocky Mountains.

[2] Mining and Scientific Press, April 17, 1875.

[3] This and other details from a report by Orlando McCraney, E. M.

The Canada Hill vein, from which practically all the production from the property has come, strikes north and dips 20° west, though nearly flat in some places. It pinches to a seam in some sections but is said to average 16 inches to 18 inches thick. It carries free gold, considerable pyrite and chalcopyrite and smaller amounts of sphalerite, galena, arsenopyrite and stibnite. The pay shoot mentioned above occurs between granite walls and is said to be the longest mined in the district.[2] Allowing for about 10,000 tons of $50 ore as the early-day output for which there is no definite record, the total yield has been about $1,130,000 from 49,000 tons of ore. This pay shoot is bounded by 2 cross faults which converge in depth. The Canada Hill vein is faulted west 180 ft. by the St. Louis cross vein. There is said to be fracturing instead of enrichment at the intersection.

McCraney described 2 systems of veins on this property: (1) a flat-dipping group with north strike, of which the Canada Hill vein is most important; and (2) a steeply dipping group striking east. Movement on the latter series has faulted the north-striking veins. Both series have branches which serve as links with the other veins. The principal veins he notes, besides the Canada Hill are:

The Greenman, and its north extension the Independence. Its outcrop is parallel to and 450 ft. west of the Canada Hill vein and it dips east 15° to 30°, crossing the latter at a depth of 250 ft. without faulting. It has a tunnel 600 ft. long and an inclined shaft 200 ft. long. Some ore from it is said to have yielded $35 to $60 a ton.

The Grant vein striking north and dipping 45° E., averages 16 inches thick. It has a shaft 180 ft. long on the vein and 2000 ft. of other work, including a drain tunnel. It is claimed the last milling of 500 tons yielded $19 a ton.

The Wide West vein outcrops 1 ft. wide 600 ft. east of and parallel to the Canada Hill vein. It has made some production on an adjoining claim outside this property.

The Kellogg vein, parallel to and 500 ft. west of the Greenman, has also produced on an adjoining claim but has not been worked on this ground.

The Butterfly and Beckman are flat, east-striking and south-dipping veins on the south end of the property. They have no record of production here, and have been only slightly prospected.

The St. Louis vein strikes N. 65° E. and dips 70° to 80° N. It can be traced about 7000 ft. on the surface and varies from 1 ft. to

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[1] From a report by Edward C. Uren, Mining and Civil Engineer, Nevada City.

[2] Edward C. Uren report, *ante*.

12 ft. in width including the altered granodiorite which forms the walls. It has faulted the north-striking veins. The principal openings on the St. Louis vein are the Alpine adit, 400 ft. long and the drain tunnel run along it for 250 ft. to connect with the Canada Hill workings. Such ore as has been milled from it has yielded $3 to $4 a ton.

This property covers 1482 ft. on the Canada Hill vein, 1444 ft. on the Greenman-Independence, 5270 ft. on the St. Louis and 1500 ft. on the Grant vein. At present there is no equipment on these claims, but water and electric power are available nearby and other conditions are satisfactory.

Centennial Mine, adjoining the Osborne Hill on the south, had its principal period of activity before it became a part of the Sultana and later of the Empire Star.

It was worked in 1855 by John Judd. In 1859 it was bought by the Wide Awake Company, who worked it to a depth of 300 ft. According to Bean's Directory of Nevada County, a crushing of 400 tons yielded $26,000 or $65 a ton. Little was done between 1861 and 1876 when John Trenberth and Co. took the mine and named it the Centennial. This Company produced $200,000 in 4 years and the total yield was over half a million dollars.[1]

There are 2 shafts, 300 ft. apart and the later of these was 650 ft. deep in 1891. The vein dips 30° W. and is reported from 6 inches to 14 inches thick. It contains 3% sulphides, worth $150 a ton (old gold price). Six levels were opened [2] and a length of 800 ft. was prospected and an ore shoot 250 ft. long was found. The country rock is diabase (porphyrite) breccia. The yield of the ore appears to have been consistently high, as witnessed by the following contemporary news items:

Oct. 21, 1876: 50 loads gave $5000.
Jan. 27, 1877: 140 loads gave $11,000 (without sulphides).
May 12, 1877: 60 loads gave $3300 in free gold.
Sept. 14, 1878: 94 loads gave $9096.
July 12, 1879: 500 loads including sulphides gave $34,928.20.
Feb. 18, 1880: 100 loads including sulphides gave $8,000.

Chester Butler prospect is on the Avery ranch across the road from Limekiln school. A prospect shaft had been sunk about 25 ft. in August, 1940 in search of a vein which had yielded gold ore reported to assay $28 a ton on the Arnold ranch, a few feet distant.

The Butler workings, in serpentine, had not yet revealed the vein which is reported to dip east and strike northwest between a slate footwall and serpentine hanging wall. The Arnold workings are idle. There is a small tool house at the Butler shaft.

Crown Point Mine. Now controlled by Empire Star Mines Co. It was worked from the early 1880's until 1899 by former owners. It is ½ mile east of the center of Grass Valley and just south of Wolf Creek. The early production down to a depth of 400 ft. was claimed to have been $130,000 of which $80,000 was found in one rich "bunch" as is characteristic of gold deposits associated with serpentine. The vein varied from inches to 7 feet in thickness and was said to average $17 a ton free gold and 3% of $60 sulphides. It strikes northwest and dips 70° to 80° N. A depth of 620 ft. was reached by 1897 and a total of 2500 ft. of drifting is reported. The vein is in the serpentinized porphyrite near the contact with Calaveras slate. Lindgren mentions a peculiar occurrence of ore found in a 20-ft. crosscut northward from the 200-ft. level. This ore consists

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[1] Mining & Scientific Press, Feb. 14, 1891.

[2] Cal. State Min. Bur. R. XI, p. 280.

> "chiefly of calcite, pyrrhotite, chalcopyrite, with some ordinary pyrite; the sulphurets occur as heavy masses 5 to 6 inches thick along the vein and a sample assayed by Prof. Chas. E. Munroe contained 17.5 ounces of gold and 12 ounces of silver per ton, no free gold being visible."

Eagle Bird Mine. This old mine 7 miles east of Washington has been closed down for 6 years. It has been adequately described in our 1918 and 1930 reports, but as the latter is out of print the following details are taken from it:

> "The holdings include three patented claims, 160 acres of patented timber land and four locations on another vein, which runs parallel to the Eagle Bird vein about 600 feet to the west of it and is practically unprospected. The claims extend southward from South Yuba River for 4500 feet at elevations increasing from 3500 to 5000 feet.
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> "From the shaft, which was sunk on the vein on an incline of 65° to 800 feet, levels numbered 1 to 8 were run the following distances south along the vein at the depths indicated below the surface:

Level	Depth	Distance drifted south
1	62 feet	560 feet
2	132 feet	690 feet
3	192 feet	850 feet
4	272 feet	780 feet
5	374 feet	960 feet
6	476 feet	930 feet
7	578 feet	220 feet
8	680 feet	250 feet

> "The drifts run north of shaft were short. No. 3 level was run 320 feet north, No. 4, 195 feet and others less. An adit level, started 50 feet south of the shaft and 50 feet above it, was run south 1185 feet, gaining backs of about 700 feet.
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> "The workings could not be visited because of insufficient power for hoisting. Both walls are reported to be granodiorite to the sixth level, but 'diabase' forms the footwall on the seventh level and shows on the south from the fourth level.
>
> "Only a small amount of work has been carried on irregularly in late years. In the previous work, the south ore shoot was stoped through from the winze below No. 6 to a height of 160 feet above the adit level. Below No. 6 level this shoot, which was reported to be 375 feet in stope length by as much as 12 to 20 feet thick in the upper levels, narrowed to 100 feet in length. Another ore shoot was also stoped on the south side of shaft. In the No. 8 level the vein was wide but too low grade to be ore. An orebody 35 feet long by 7 feet thick is reported between No. 2 and No. 3 levels north of the shaft.
>
> "There is a mill of ten stamps and mine equipment includes two air compressors, drill sharpener and hoist. Water from South Yuba River has been used in the past for power and the property is supposed to have rights of long standing to 1000 miners inches but complaint has been made that other users have been cutting off a large part of this in summer. There are several good buildings on the claims.
>
> "In 1926, a crew of a few men worked 64 days. Since then only about 40 feet of new work has been done underground in addition to keeping timbering in repair. In 1928 a new head dam was built, diverting nearly all the summer flow into the company's ditch. When visited in 1929, principally repair work was being carried on by Clayton Chatfield, superintendent, and a few men."

Bagdad-Chase Copper Company took the property in 1935 and did some prospecting but quit work without milling any ore.

The total production of the mine is not known. In 1884 it had already been opened to a depth of 125 ft. and was producing. It had a small mill and the ore was averaging $25 a ton, with very rich sulphides. By 1890 the shaft had 6 levels. In 1890 and 1891 under the name of Diamond Creek Consolidated, it produced $190,483 gold and $2100 silver. There was another period of activity from 1898 followed by litigation which was not settled until 1909. Shortly after a legal decision in favor of the Eagle Bird owners, the mill was burned down. Work was not resumed until 1914 and a 10-stamp mill was built in

1915. A total of about 4000 tons of ore was milled between then and 1932. This is reported to have yielded from $1.00 to $11.00 a ton.

Empire Star Mines Company, Limited was incorporated in Delaware in April, 1929, to take over and operate the Empire Mine and adjacent holdings from Empire Mines Company, and the North Star and other mines at Grass Valley which had been previously operated by North Star Mines Company. It is said the Empire had been sold in 1928 by Empire Mines and Investment Company to Empire Mines Company for $250,000 cash. Empire Star Mines Company, capitalized for $2,000,000 in shares of $10 par value, is said to have issued 49% of its stock to the North Star stockholders in exchange for the stock of North Star Mines Company. Newmont Mines Company in 1939 controlled about 36% of Empire Star Mines Company stock.

Headframe and surface plant, Empire Mine, Grass Valley

John R. C. Mann is general manager of the company's Grass Valley operations and properties. In addition, they own and have been operating the Murchie Mine near Nevada City and the Zeibright Mine in the mountains near Emigrant Gap, both under the management of R. J. Hendricks. The main office is at 14 Wall St., New York; Fred Searls, Jr., president, Geo. B. Agnew, vice-president, and H. E. Dodge, secretary-treasurer. Dividends have been paid every year since 1931. The total holdings in Nevada County are about 1800 acres, most of it in the heart of the Grass Valley district, which has the longest record of successful quartz mine operation and the largest gold output of any quartz mining district in the state.

The previous histories of these mines, and the geology of the mines and district have been discussed in the following publications to which the reader is referred: U. S. Geol. Survey, 17th Report, Pt. 2; and Geologic Folio 29; Cal. State Min. Bur. Mines and Mineral Resources of Nevada County, 1918; State Division of Mines, Rept. XXVI of

State Mineralogist, No. 2, Apr. 1930, Nevada County; U. S. Geol. Survey Prof. Paper 194, by W. D. Johnston, Jr., 1940.

The present holdings of this company include a great many mines and veins that have been separately described in the older reports, such as the Coe, Crown Point, Hermosa, Rocky Bar, Gold Hill, Hudson Bay, Grange, North Star, East Star, Central, New York Hill, Granite Hill, Pennsylvania-W. Y. O. D.-Golden Treasure-Telegraph, Cassidy, Bowery, Empire-New Ophir-Daisy Hill, Omaha-Lone Jack-Homeward Bound and Wisconsin (the last four being the old Empire West holdings), Orleans-Prescott Hill-Kings Hill, Heuston Hill-Sebastopol-Biggs & Sims-Electric (the last two groups formerly were the Sultana Group) and many others.

The complex mineralization resulting from the filling of fissures belonging to several different systems of varying dip and strike has led to the formation of a large number of orebodies, some lying in veins mentioned above, others in branches, intersections or junctions of veins. The more important veins are:

The Empire vein strikes north and dips west at an average angle of 35° down to about the 2800 ft. level where it steepens to 55°. Its upper section was in diabase but at 1700 ft. in depth it passed into granodiorite (quartz monzonite) in which it remained to the present bottom. This vein has been mined through the Empire inclined shaft sunk on the vein to 2800 ft., then in the hanging wall because the vein steepened, to 4600 ft. From the 4600-ft. level an inclined winze was sunk on the vein near the south end of the main ore shoot to the 7500-ft. level. The main Empire ore shoot has been the largest and most productive. It pitched north, had a maximum stope length of about 2500 ft. and carried from 12 inches to 15½ inches of ore as a rule, but in an exceptional case a width of 8 ft. of quartz was mined. Barren or narrow zones where the ore assayed well but was too narrow to mine profitably were found at intervals for depths of several hundred feet. This shoot has been mined in a number of small stopes. The increase in the price of gold has permitted working some ground previously left, but results of prospecting below the 7000-ft. level in the past few years have not been as good as could have been wished. However, a 100-h.p. hoist has lately been installed at this winze. On the Magenta claim, north of the Empire shaft, reopening of a shaft has recently been started to facilitate mining of ores on the Empire side. J. R. C. Mann states there has been no change in the character of ore milled from the Empire in the past 10 years, and the same milling practice which was illustrated in our 1930 report is being followed. Besides the Empire vein, the O.K., New York Hill, Newmont and other veins are being worked in the Empire mine section. On the north the Empire vein turns east in a series of crossings in the region of the fault zone along the north side of the granodiorite batholith. This fault strikes northwest and dips steeply northeast. On the south, the vein also dies out by dissipation of the fracture along repeated crossings.

The Pennsylvania Vein Complex is worked through the Pennsylvania shaft and ore is hauled in trains to the Empire mill. Lower levels have also been worked through crosscuts from the Empire.

These veins are about parallel in dip and strike to the Empire in the northern part of the workings and lie about 2500 ft. to 3000 ft. distant. To the south the Pennsylvania vein joins the X vein which strikes southeast and dips southwest. In 1914 when the North Star incline reached a depth of 6300 ft. on the dip of the North Star vein, this X vein was encountered. It strikes about parallel to the North Star vein but dips southwest, or opposite to the latter. The X vein cut off the North Star and continues downward. It was called the No. 1 vein in the North Star and was followed and stoped for a length of 1400 ft. from the old compromise line (about 5400-ft. level of North Star and near the 4600-ft. level of Empire) to the 8600-ft. North Star level. The X vein is a strong fault fissure on the 4600-ft. Empire level, where it is filled with brecciated and ground country rock and comparatively little quartz. A section described as typical shows a lens of quartz near one wall (in a fissure several feet wide filled with broken and crushed rock), with the next lens overlapping or nearby, near the other wall.

The W. Y. O. D.-Telegraph vein system also belongs to this series of west-dipping veins which are alike in many respects to the Empire. The Pennsylvania, W. Y. O. D. and other veins of the Osborne Hill system were producers of good ore for years before their acquisition by the Empire, but their most extensive and successful operation followed that acquisition. These veins are usually narrow, dip 20° to 40° W. and while generally striking north, may curve southeast or northeast as in the case of the Pennsylvania. The workings have been partly in diabase, but in depth are in granodiorite. Average widths of 12 inches to 18 inches are reported. Two ore shoots each about 600 ft. in stope length were mined between the 1000-ft. and 2400-ft. level of the Pennsylvania shaft. About 1000 ft. in length on the X vein from the 1400-ft. level to 4600-ft. level of the Pennsylvania carried ore irregularly distributed. It was also worked in the North Star (see ante) but did not yield as good a grade of ore as the Empire and other veins.

A new steel headframe has recently been erected over the Pennsylvania shaft, and a new 250-h.p. hoist and 2 compressors have been installed.

Veins in North Star workings. It has been possible in the past to publish more details concerning operations during the life of North Star Mines Company than in the case of the Empire and the reader is referred to past reports. In our 1930 report (April chapter of Report XXVI of the State Mineralogist) tables were published showing average value of ore at various depths in North Star Mines and production of these mines for the 14-year period, 1914-1928 inclusive. The mine had been stoped to the 8700-ft. level (on dip) by 1928 and conditions underground, taken in connection with the general 'boom' in other lines of business (always an unfavorable time for gold mining) were not too promising. Like the Empire, the North Star holdings were made up of many mines and groups that had previously been productive. The combined production of the Grass Valley holdings of North Star Mines up to the end of 1928 was $33,267,734.

At the time of transfer of the property to Empire Star Mines Company (May, 1929) the ore was marginal and operations had been carried on at a loss for 6 years. No. 1 or X vein was low grade. The North Star vein system which had yielded the larger part of the gold taken from the mine, had yielded little ore below the 5300-ft. level, and was apparently cut off by the No. 1 or X fault vein at the 6300-ft. level. No. 2 vein which branches from No. 1 vein southeast of Central shaft on the 8600-ft. level had been prospected in the levels above, but died out about 800 ft. above the 6300-ft. level, and evidently had not given promise of its future worth. It was small, with hard walls. No. 3 vein was also prospected between the 7200-ft. and 8600-ft levels. Neither of these veins up to that time had given important results although 4717 ft. of work had been done in 1928 on No. 2 vein and 2158 ft. on No. 3.

Recently, however, conditions have greatly improved. Besides work at different places in the upper levels for company account, which, combined with lessee's ore keeps 40 stamps of the Central (North Star) mill busy, a number of veins are being worked in the deepest levels. Among these, No. 2 vein is the most valuable. It is a west-dipping vein striking north. It is being mined through the North Star Central vertical shaft. From the 8600-ft. level (3600 ft. vertical depth) of this shaft, and a short distance south of shaft, a 2½ compartment inclined winze is being sunk which has reached an inclined depth of 10,450 ft. (about 4800 ft. vertical) by March 20, 1941. A new hoist is to be installed at the top of this winze to prepare for work to greater depth.

Ore from this vein shows a higher percentage of sulphides than in the upper levels. Pyrite is plentiful, with some galena. High assays are reported. A section of the Central mill, where 20 stamps are used for intermediate crushing, followed by tabling, a jig, ball mill and flotation, is being used to handle ore from No. 5 ore shoot on this vein.

No. 3 vein is the extension of the No. 2 fracture north of and under the X vein.

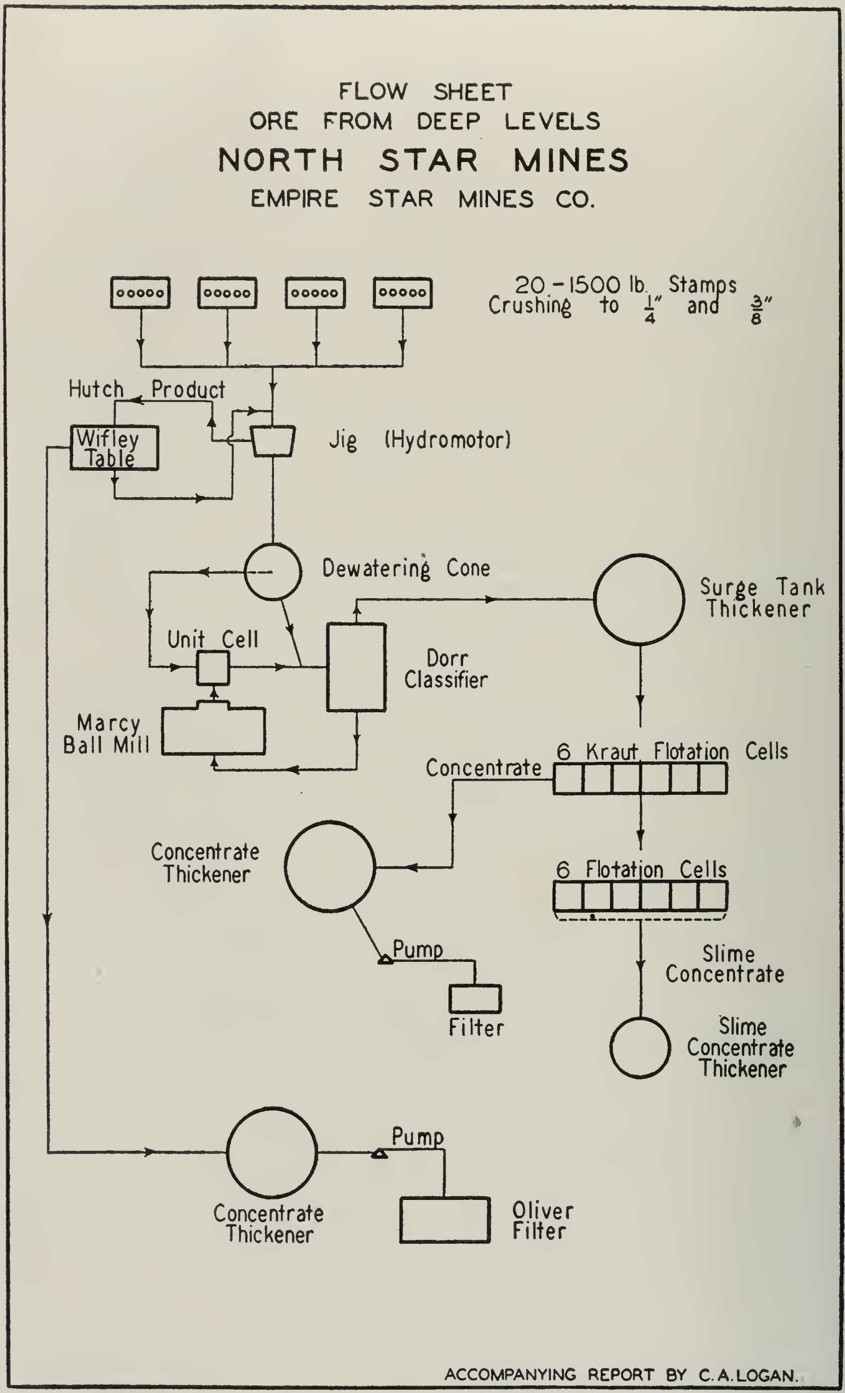
Besides the productive veins there occurs a series of crossings which are steeply dipping barren fissures of pre-mineral age striking generally northeast. The importance of crossings is a matter of dispute; A. F. Duggleby believed them favorable for ore accumulation and enrichment only because intersections of veins with them afforded a greater area of opening for passage of solutions. Arthur Foote believes they are a controlling feature.

SUMMARY.

The large block of ground worked in the 2 mines is cut into rhombohedral blocks by (1) a series of north-striking conjugate veins (Empire, Pennsylvania, No. 3A) roughly parallel to the main diabase-slate contacts; (2) a series of northwest-striking conjugate veins (X, North Star, New York Hill, etc.) parallel to a limiting fault line; and (3) earlier barren crossings.

Production of Empire-Star Mines

Empire Mine holdings before 1929	$35,048,752
North Star Mine holdings before 1929	$33,267,734
Empire Star Mines since 1929 (fine oz.)	1,074,284



FLOW SHEET
ORE FROM DEEP LEVELS
NORTH STAR MINES
EMPIRE STAR MINES CO.

20 - 1500 lb. Stamps
Crushing to $\frac{1}{4}$" and $\frac{3}{8}$"
Hutch Product
Wifley Table
Jig (Hydromotor)
Dewatering Cone
Surge Tank Thickener
Unit Cell
Dorr Classifier
Marcy Ball Mill
6 Kraut Flotation Cells
Concentrate
Concentrate Thickener
6 Flotation Cells
Pump
Slime Concentrate
Filter
Slime Concentrate Thickener
Pump
Concentrate Thickener
Oliver Filter

ACCOMPANYING REPORT BY C. A. LOGAN.

MILLING.

Three different plans are followed in milling ores from different sections of the holdings. At the Empire mill, for which the flow sheet was illustrated in our 1930 report, the eighty 1780-lb. stamps, amalgamation plates and concentrators handle ores from the Empire and Pennsylvania mines. Concentrate and tailing from these ores and concentrate from the company's other mines are treated in the Empire cyanide plan which has a capacity of 25 tons to 30 tons of concentrate daily.

At the Central (North Star) Mill of sixty 1500-lb stamps, 40 stamps called the free-gold section are used on ores mined for company account in the higher levels of the North Star and lessees' ore. This ore is crushed to 28 mesh and the pulp containing 20% solids passes over plates and Plat-O Deister tables, and the table tailing is reground and treated by flotation.

The other 20 stamps are used as intermediate crushers in a circuit shown (see attached). This section of the mill treats the ore coming from the deepest levels of the North Star Mine (10,600 ft. on the incline). This ore shows more sulphide (mostly pyrite) than in the higher levels.

Empress Mine. In secs. 8 and 17, T. 16 N., R. 8 E., four miles west of Nevada City. First called the Dull or Newtown Mine and including the Mulcahy Mine, it was worked in 1920 when an inclined shaft was sunk 200 ft. on the vein and 300 ft. of drift was run. The vein was 2 ft. to 3 ft. wide at that depth and carried some bunches of sulphide ore. A 10-stamp mill was put on the property in 1922 and was operated a short time by Newtown Mining Company but less than $2 a ton was saved and work stopped in 1923. In 1932 Empress Gold Mining Company was formed and worked until January 1935 when Republic Gold Mining Corporation came into control. A new mill was completed, using flotation, late in 1934. In that year, 12,762 tons of ore was treated, yielding 2% concentrate. The year 1935 was the most important. The mine was opened to a depth of 1000 ft. and an orebody 800 ft. long and 8 ft. wide was claimed on the 800 ft. level. During the year, 46,635 tons was mined and milled, yielding $233,485 in gold and $49,587 in silver. The production was from sulphides, which carried about 10 oz. silver for each ounce of gold, the gold yield averaging $5 a ton of ore and silver $1.06 a ton. A little lead and copper were also recovered.

In March, 1936 work had to be stopped because of caving in and around the shaft, allegedly due to mining a shaft pillar. Soon after, several creditors levied attachments on equipment. Republic Gold Mining Corporation went into bankruptcy, listing liabilities of $172,498 and assets of $65,484. George J. Rector, Nevada City, filed suit for possession of the property on the ground that the purchase price had not been paid in full. The late R. C. Eisenhauer estimated the cost of reclaiming the mine with a new shaft would be $150,000.

Ethel Mine. Two patented lode claims, Ethel and South Ethel. 40.07 acres in NW. ¼, sec. 35, T. 18 N., R. 11 E. (M. S. 4820). Other adjoining land was also claimed in 1936. California Lands, Inc., 785 Market St., San Francisco, Benjamin Goodwin et al. are the owners.

The claims are 8 miles from Washington at an elevation from 4800 ft. to 5700 ft. above sea-level, on the north side of Canyon Creek.

At present the workings are inaccessible and the following details about underground conditions are from reports by F. McMillan (1908) Albert Maltman (1909) J. A. Bryson (1915) and W. B. Gilroy (1936).

Work started about 1896 with the sinking of a prospect shaft which finally was connected with the adit 200 ft. deep, but the principal activities and production were in 1905-1908. The country rock is granodiorite with a ''diorite dike'' reported to form the footwall in some sections. The strike of vein is about northwest and dip from 40° to 60° NE. The vein varies from 1 ft. to 9 ft. wide.

According to the report of Maltman, formerly superintendent, the tunnel was run 600 ft. through country rock before striking the vein; for nearly 200 ft. farther the vein was only 3 inches or 4 inches wide and was not considered worth exploiting; then, he says, it ''commenced to attain more width, sometimes almost 6 ft. and for a distance of 465 ft. along the vein and almost 300 ft. in height, the pay ore maintained a remarkable regularity.'' . . .

His figures disagree with those given by McMillan who stated ''At a distance of 778 ft. from the portal of the tunnel, the vein was encountered and shows a small veinlet of quartz in granite. The tunnel was driven northwest along the vein for a distance of 275 ft., at which point a fault plane intersects the vein from the south. It strikes south magnetic, and dips east at an angle of 45°. It is a well-defined fracture, showing considerable clay along the wall, with some quartz stringers. A drift has been driven on the apparent fault-line for 45 feet. A few feet to the northwest of the fault the intrusive dike of diorite is seen on the footwall side of the vein. At this point the dike shows evidence of having been under great pressure, a greater part of the material assuming a schistose structure, which has been taken for slate. It extends along the line of the tunnel for about 200 ft. and does not appear again in the tunnel to the northwest. Just to the northwest of the fault the payshoot commences, and continues northwest beyond the shaft.''

At a point in the tunnel 1419 ft. from the portal an inclined winze was sunk 112 ft. The 100-ft. level in winze was run 70 ft. south and 20 ft. north. Most of the ore between this level and the adit is said to have been mined. The pay shoot is said to end 100 ft. north of the winze, but the main adit was run 400 ft. north and west of winze. The face is reported to be in decomposed granite showing veinlets of quartz.

The company has a record of the production of $65,959 in bullion, which came from a reported total of 4500 tons of ore crushed between August, 1905 and September, 1907 in a 10-stamp mill. The location and size of stopes is not known but evidently one-half or more of the ore came from below the main adit, underhand stoping being reported for a length of 170 ft. and depth of 12 ft. besides the winze workings. The vein was said to be 2½ ft. to 3 ft. wide in the winze, where the depth reached is said to be 300 ft. on the dip below the outcrop.

The contour of the surface would permit driving another adit considerably lower than the first. A length of 3000 ft. along the strike northwest of the adit face has not been prospected.

At the time of Gilroy's report (Dec. 1936), the boarding house and bunk house building and office and assay building remained, and there was a stand of 3,040,000 board ft. of timber, over ⅔ of it sugar pine. There is plenty of water on the claims. The only work in recent years was some shallow trenching done on the South Ethel claim and the beginning of a crosscut adit from the Star claim toward the Ethel vein, about 1934.

Gaston Mine (Gambrinus and California). In Washington district 6 miles northeast of Washington. It has been described in detail in many of our past reports, beginning with Report VIII. Not much new work has been done since the 1930 report, wherein the operations of the Rescue-Eula Mining Company were described. When the Gaston Gold Mining Co. quit work in 1918, the superintendent claimed 100,000 tons of $4 ore blocked out and stated the total cost of mining and milling, including overhead was $3.92 a ton. They had operated for 20 years.

In December, 1940, Jack Warner, Reno, Nevada had begun sampling the mine with a view of reopening it if results are encouraging.

Giant King Mine is 2 miles south of Washington. Four lode claims have been segregated from sec. 13, T. 17 N., R. 10 E., (a railroad section) but have not been patented.

It was first located and prospected in 1874 by Captain Miller. No. 1 adit (now caved) is a crosscut 100 ft. below the outcrop and is said to have reached the vein in 180 ft. and to have "passed through it for 74 ft." No. 2 adit, also a crosscut, reaches the vein at a reported vertical depth of 254 ft. and 486 ft. from the portal. No. 3 crosscut adit is about 200 ft. below No. 2 and is 1000 ft. long. Although it has received notice in the past because of the size of the vein, there does not appear to be a record of production until 1936 and again in 1938. J. M. Hoff operated the mine then and some ore was hauled to the Gracie mill near Nevada City. The concentrate was shipped to a smelter at Tacoma and the writer has been unable to learn the yield of this ore. According to T. E. Massie, Sacramento, about 3000 tons was mined during those operations. A small stope was opened on the Giant King vein on No. 2 level and a raise was put up near the face and a little stoping was done. On No. 3 level, stoping has been carried to a height of 20 ft. to 40 ft. above the level over a length of about 120 ft. on the Jumbo vein, on an ore shoot 140 ft. long.

Late in 1939 M. R. Peterson, 1116 O St., Sacramento, and associates put a 100-ton ball mill and flotation plant on the property. In May, 1940 when development work was going on and only 100 tons of ore had been milled, the reduction plant was destroyed by fire. No work has been done since. T. E. Massie, who was employed at the mine, states this last ore was mined 6 ft. wide and yielded $9 a ton. Massie took many samples for assay on both veins. On Giant King vein on No. 2 level 29 samples taken over widths ranging from 2 ft. to 7 ft. showed variations from 87 cents to $21.35 a ton. On the Jumbo vein in No. 3 adit, similar wide variations from $1.05 to $39.55 a ton were obtained, cutting widths from 18 inches to 6 ft.

These claims extend nearly north along the west side of the Carboniferous (Pennsylvanian) slate and the dip is 50° NE. They are west of the granite belt in which most of the mines of the district lie.

Globe (Round Mountain Champion). In NE. $\frac{1}{4}$ of SE. $\frac{1}{4}$, sec. 30, T. 17 N., R. 9 E., $3\frac{1}{2}$ miles from Nevada City. Thirty years ago a shaft was sunk 160 ft. and drifts were run 80 ft. east and 80 ft. west on a vein said to be 1 ft. wide. The walls are granodiorite. No definite record of production is available.

Golden Center Mine. Cooley Butler, owner, 745 Rowan Bldg., Los Angeles. Wallace P. Butler, manager. It contains about 150 acres including the Golden Center, Peabody, Cabin Flat and Scotia mines, and mineral rights under Grass Valley west of South Auburn St. and south of West Main St. A detailed description of the mine and workings appeared in our 1918 report. At that time the Golden Center inclined shaft had been sunk 1160 ft. on an average inclination of 28° W. on the Dromedary vein and the main ore shoot had been stoped from the 500-, 600-, 700-, 750-, 800-, and 900-ft. levels north of the shaft. These levels were run from 500 ft. to over 700 ft. north, and were stoped as far as drifted. The levels above the 500 had been worked in early days. This vein, from 1 ft. to 3 ft. wide (16 inches at the 700-ft. level) yielded good ore carrying $10 to $60 a ton with 2% sulphides worth $50 a ton (old gold price).

New steel headframe on Scotia Claim of Golden Center Mine. Grass Valley

The Garage vein parallel in dip and strike to the Dromedary was prospected through a crosscut run northwest on the 500-ft. level, with 500 ft. of drifting. On the 700-ft. level a crosscut to the Whiskey vein showed 16 inches of ore. The Church Hill vein parallel to Dromedary and Garage veins, was also found on the 250-ft. level. A crosscut started on the 1100-ft. level toward the east-dipping Peabody vein opened a heavy flow of water that hampered work for years and contributed largely to closing the mine down. It later passed into the hands of Cooley Butler.

Work was resumed in 1931 and was carried on through the Golden Center inclined shaft until early in 1938, by which time it had reached a depth of 1900 ft. on the incline. A new vertical shaft was sunk 1000 ft. on the Scotia claim on the west side of town, this giving the same depth as the 1650-ft. level of the Golden Center. Connections were made from this shaft to the old 1100-ft. and 1650-ft. levels. The old mill was used (20 stamps and flotation) until June, 1938, when a new mill was put in operation near the vertical shaft, which is about ½ mile northwest of the old one. Most of the work has been done on the Church Hill and Dromedary veins. The latter, striking north and northwest, branches and the west branch is called the Rock Roche.

Several hundred feet has been drifted on each, the Church Hill being more extensively prospected on the strike and the Dromedary on the dip. The former ranges from a stringer to several feet in width. The veins are in general similar to others in adjoining mines and are worked with small stopes with 2 air drills in each. Work is being done on a number of levels from 700-ft. level down. Stoping has been started on the 1650-ft. level on Dromedary vein, and on the 1900-ft. level on Church Hill vein. A crew of 140 men are employed and 150 tons of ore is produced daily. An Eimco loader, Mancha trammer and mules are in use for handling ore underground.

A double-drum 150 h.p. hoist is operated at the new vertical shaft, and the old hoist is kept in commission at the incline. Three Ingersoll Rand compressors supply air through the new shaft.

Ore hoisted to the headframe passes through a gyratory crusher, Telsmith crusher, and set of rolls which reduce it to ¼ inch and it goes by belt conveyor to the mill bins. Final crushing is done by an Edinger ball mill (made at a local foundry) run by a 100-h.p. electric motor. Pulp passes through a jig, which saves coarse gold; thence to a Dorr classifier, and four size-11-S Standard square Fagergren flotation cells. Reagents used include Zanthates Z6 and B23, Aerofloats 15 and 242, $CuSO_4$, lead acetate, Na_2S, soda ash, alum and lime. Flotation concentrate is filtered and cyanided in a 5-ton plant. Flotation tailing passes over a Deister table.

Golden Gate Group, 1400 ft. north of the Idaho Maryland, contains a group of 5 veins in serpentine including the Alpha and Kentucky veins, which were worked in early days. From 1877 to 1881 the Alpha paid $20 to $30 a ton down to a depth of 120 ft. from a vein reported 20 inches to 24 inches thick. The Kentucky produced ore that yielded from $17 to $26 a ton, from a vein 6 inches to 18 inches wide. This vein had 2 ft. of ''cabby'' rock on the hanging wall, with 4 ft. of low-grade ore above it. In 1873 it produced $5000 from 300 tons of ore. In 1877 a lot of 16 tons yielded $421.10. The shaft was about 250 ft. deep in 1873, and only 150 ft. of drifts had been run. Work continued on such a small scale for 25 years, off and on, with a depth of only 300 ft. reached on the dip of vein.

Later the Golden Gate Company sank an inclined shaft 1020 ft. and drove a total of 3315 ft. of drifts, 485 ft. of cross-cuts, 420 ft. of raises and 160 ft. of winzes. There was a good mine plant and a 10-stamp mill. From 1909 to 1915 inclusive, about 8000 tons of ore was mined and milled, most of which is stated to have yielded $6.40 a ton. The concentrate was less than 1% of ore and was low grade, containing only about $45 to $50 a ton in gold.

Grass Valley Extension. This is an undeveloped property of 800 acres which corners on the Empress Mine on the southeast. Deer Creek runs diagonally through the land from northeast to southwest. There are reported to be 6 veins striking northwest or west and 3 striking northeast. There is one shaft, reported to be 70 ft. deep and to be in ore, on the land. R. J. Bauer has lately (June, 1940) been gathering up small quantities of ore from the dump and working it in a small homemade mill, handling possibly a few hundred pounds of rock a day. The owners are Mrs. L. C. Christian, Luke Williams, Henry Snyder and the Hennessy Estate.

Great Northern Gold Mines, Inc. (Hoge Mine). This comprises the old Cold Springs and Hardscrabble, and parts of the East Harmony and West Harmony in sec. 32, T. 17 N., R. 9 E., and sec. 5, T. 16 N., R. 9 E., 280 acres, 2½ miles northeast of Nevada City.

Work began on this mine in 1930. Previous to the erection of the mill in 1932, ore was crushed at the Murchie mill. The company has not worked the mine since the end of 1933 but it has been in steady operation by lessees, of whom 8 were employed in June, 1940, four working in the mine.

The vein strikes nearly east in granodiorite near a slate contact which is about 100 ft. from the shaft. The main shaft was sunk 600 ft. on an incline of 73° N. on vein. On the 600-ft. level, 200 ft. west of the shaft a winze was sunk 600 ft. on incline of 65°. The 300-, 400- and 600-ft. levels are each 1000 ft. long or more. Stoping was carried from these 3 levels nearly to the surface. On the 300-ft. level the orebody was 320 ft. long, and on the 600-ft. level, which has 1080 ft. of drifting, 760 ft. in length was ore. The ore raked west and had an average thickness of 1.75 ft. to 2 ft. Most of the work was upon the footwall vein; at times the two veins are within 10 ft. of each other.

According to A. Hoge, Jr., the average yield was $12 a ton (with gold at $20.67 an ounce) and the total production has been a little over $600,000 at this rate.

Although levels were turned at 800, 1000 and 1200 ft. depth in the winze, Hoge states no ore was found below 600 ft. On the 300-ft. level a drift was run 680 ft. on the Genasci vein, going south of east in slate but this did not develop ore.

Ore passes from the 16-inch crusher to the bin and by belt conveyors to a fine crusher and to the No. 64½ Marcy ball mill, which is operated by a 75-h.p. motor. Pulp passes from the mill to a double-drag classifier which delivers fines to 8 Kraut flotation cells, 6 being roughers and 2 finishers. Concentrate from the latter is pumped to a thickener, and to a small Oliver filter, and shipped to Selby smelter. The rest of rougher product goes back to the circuit and rougher tailing is sent to a Plat-O concentrating table. The mill has recently been running 1 shift. Zanthate No. 6, sodium sulphide and pine oil are used for flotation and lime chiefly for clarifying tailing.

Concentrate forms about 1% of ore and is mostly pyrite with some galena and a little arsenic and antimony. The value of concentrate varies from $200 to $800 a ton. There is 1 oz. silver to 3 oz. gold in the bullion. No gold is amalgamated.

The principal items of mine equipment are a double-drum hoist run by a 75-h.p. motor and 1075-cu. ft. Laidlaw compressor with 175-

h.p. synchronous motor. Mill and other equipment are housed in good buildings covered with galvanized iron.

Hot Water Mine is at Graniteville, 28 miles northeast of Nevada City, at an elevation of 5000 ft. Betty Anne Gold Mining Corporation, Sacramento, (incorporated 1931, lapsed 1935) is reported to have done some work and still to own the ground. Baker, Casey and Walther are the present lessees, with Thomas E. Casey in charge.

The headframe and mill at the old shaft were burned late in 1938. This shaft was 120 ft. deep with a number of short drifts. A new shaft has been started about 1000 ft. northwest of the old one and was 58 ft. deep on an angle of 45° on June 12, 1940. The workings, inaccessible because of pump trouble at the time of visit, are said to include also a drift 30 ft. north and 100 ft. south at 50 ft. depth. The vein varies in width from layers of quartz 10 inches wide on each wall in the shaft, to a total of 3 ft. to 4 ft. according to Casey, in the drift and sump. Both walls are granodiorite and the ore is inclined to vary greatly in value, assays ranging from $14 to $500 a ton. An ore shoot 70 ft. long is claimed. Only a small amount of ore is crushed yearly most of the work being done in summer and fall.

The mill at the new shaft consists of a grizzley, rock breaker, 5 medium weight stamps and 8-ft. plate for amalgamation. Power for mill is supplied by a Buick automobile engine and a Dodge engine is used for hoisting.

Water for power is taken from Poorman Creek through ½ mile of pipe to the old shaft where a Pelton wheel operates a 30-kilowatt 500-volt electric generator. A power line 1000 ft. long runs thence to the new shaft. A 1½-inch centrifugal pump, operated by a 5-h.p. motor, runs 8 hours out of 24 to keep the shaft dry. From 4 to 6 men are employed.

IDAHO MARYLAND MINES CORPORATION

By H. M. Wolflin, *Assistant Manager*

In 1935, the Idaho Maryland Mines Company and Idaho Maryland Consolidated Mines, Inc. were consolidated into one corporation known as Idaho Maryland Mines Corporation and since then the combined holdings, including Brunswick and Idaho Maryland Mines have been operated as a single unit with Edwin Oliver, President, Errol MacBoyle, Executive Vice President and Albert Crase, General Manager of the consolidated corporation.

Earlier history of the several increments of the Idaho Maryland holdings has been covered by the following State Mining Bureau publications.

"Mines and Mineral Resources of Nevada County"—1918

"Report XXVI of the State Mineralogist"—1930

From 1930 to 1940 inclusive, development and operations proceeded systematically and smoothly with the production of 2,186,381 tons of ore from which bullion and concentrates to the gross value of $26,767,574 were extracted and sold. Dividends of $5,723,965 were paid.

During the eleven-year period covered by these notes a new method was used to sink an Idaho #2 (round) shaft to a point below the 1000-

foot (vertical) level. This shaft was put down by a large core-drill which was developed on the property. The drill made a hole 5 feet in diameter more than 1000 feet in depth. The cost of sinking the single compartment in this way was well under the cost of conventional methods of sinking. The New Brunswick shaft was sunk from the 1400-foot level to a point near the 3300-foot level and at the end of 1940 sinking operations were being continued, although no development of importance had been undertaken below the 1600-foot level. The Old Brunswick shaft was extended to the 1100-foot (vertical) level. The 2000-level of the Idaho was connected with the 2300-level of the New Brunswick shaft and the entire property was being operated as one mine. The Idaho 30 winze was sunk from the 2000-level to a point below the 2700-level (vertical). The Idaho 45 winze on the Morehouse vein was sunk 800 feet (on the incline) below the 2000-level. Sinking operations were being continued. During the eleven-year period 228,901 linear feet (43⅓ miles) of new headings were driven, in addition to 270,380 cubic feet of rock excavation and 130,921 feet (24¾ miles) of diamond drilling. The number of employees had increased until about 950 were working at the end of 1940.

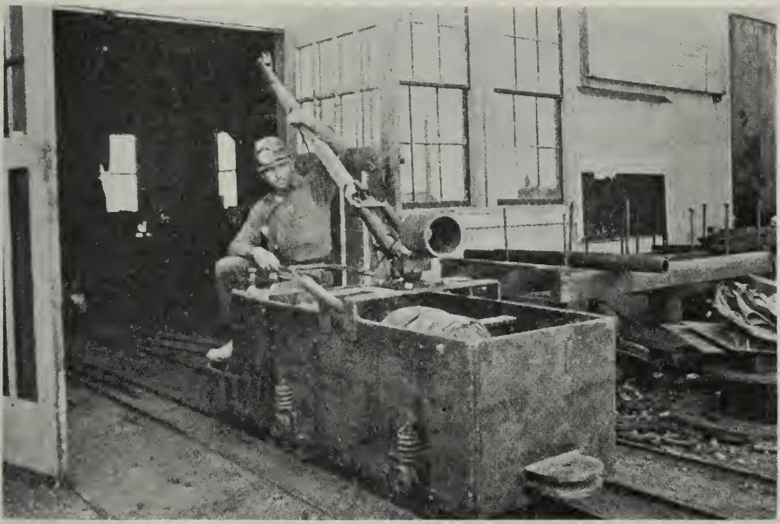
During the period the Idaho 20-stamp mill operated steadily. Ore-treatment capacity was increased by the construction of a new mill near the main Idaho shaft where two Marcy mills with flotation equipment, a cyanide plant for the treatment of concentrates and sand were capable of treating 700 tons in 24 hours. At the New Brunswick mill, capacity was increased to slightly more than 600 tons in 24 hours through the installation of a Marcy mill, a re-grind mill and other equipment.

At the end of 1940 steel was on the ground for the installation of a new 135-foot headframe at the New Brunswick shaft. An Ottumwa double-drum hoist with a 1000-horsepower motor, capable of operating 6-ton skips to 4800 feet vertically, was being installed on the surface as was a 600-horsepower Norberg man and material hoist with a single 8-foot drum.

The sustained effort at underground development had resulted in the opening of more than 40 veins which have produced commercial ore. In fact about half of that number continue to produce steadily. Although these veins vary in width from a few inches to thirty feet much of the stoped ore has come from veins of from 10 inches to 40 inches in width, most of which dip in excess of 40°.

Idaho Maryland Mines Corporation. The accompanying article, prepared by Hugh M. Wolflin, assistant manager, does not give due credit to the human factor that helps make mines. The lifting of the Idaho Maryland Mines from the status of a disappointing 'has-been' to the position of leading gold producer of California in 10 years has been due to local initiative and to the skill of local miners and engineers. It is one of the best achievements of this generation of California gold miners, as it involved simultaneously the working of properties that had baffled some of the best known engineers, the gathering of capital under the handicap of debt and the failure of these predecessors, and the building up of a competent organization sufficiently motive-minded to anticipate necessary steps. It is to be regretted that the staff could not be persuaded to prepare for publication the detailed satement which these mines warrant.

The great Eureka-Idaho-Maryland ore shoot lay nearly horizontal in the Eureka mine, beginning at a depth of 100 ft. and stopping between 600 ft. and 700 feet deep. It was worked for 1600 ft. in length in the Eureka and for 4000 ft. in the Idaho and Maryland. The pitch of the ore zone was so flat toward the east that in 5600 ft. on the strike it reached only to the 1900-ft. level. The eastward extension of work on this vein complex has furnished the ore mined since 1930. The general appearance of the mine in 1930 was described in our 1930 report. The eastern limit of this productive area has since been carried about 500 ft. farther, and the ore mined since from the Idaho-Maryland veins has come from this length of about 1500 feet, and from above the 2000-ft. level. Stoping is now going on in this section between the 750-ft. and 2000-ft. levels. Ore shoots vary from 100 ft. to 1000 ft. in length. Methods of mining depend on conditions of veins and walls, which vary widely because of the great number of veins worked. There is no uniform method of drilling and blasting. Ingersoll Rand drilling equipment is used. Hot milled detachable bits and SCR 120 drilling machines are used for stoping. Extra Gelatin powder, 30% and 40% is used for blasting.



Electric trolley locomotive, Idaho-Maryland Mines. These are built in the mine shop for $300 each. *Photo by courtesy of Albert Crase*

It is 7000 feet from the main Idaho Maryland shaft to New Brunswick shaft. The 2000-ft level of the Idaho (446+ ft. above sea-level) has been connected with the 2300-ft. level of Brunswick through a crosscut. Idaho No. 2 shaft, a round single-compartment untimbered shaft for handling men and materials and for ventilation was sunk with the Newsom drilling machine, a core drill evolved at this mine, as this was the first shaft of the kind ever sunk. It is vertical, 5 ft. in diameter and no explosives were used in sinking it so the walls are much firmer than in ordinary shafts. This shaft is between the two above named.

Generally speaking, no drastic changes appear to have been made in interpreting the geologic conditions covered in past reports. Albert Crase regards the Idaho Maryland vein system as one that has been interrupted in strike by a series of three small faults, not sufficient in throw to separate the segments. The hanging wall is diabase which has generally been in the form of a dike 20 ft. to 30 ft. thick. The footwall is serpentine. The veins seen by the writer varied in thickness from 6 inches to 12 feet, and Wolflin mentions some 30 ft. wide. In the Idaho and Maryland old workings, Lindgren gave the dip as 55° to 73° S. and strike N. 77° W. The dip is flatter and strike near west in some places.

Headframe and ore bins Brunswick Mine, Grass Valley

The geology of the Idaho-Maryland section of these holdings is entirely different from that of the Empire and North Star which are in granodiorite (quartz monzonite) in the deeper levels. The Idaho Maryland is north of the large fault along the north side of the granodiorite, and so far as known granodiorite has not yet been found in any of that mine's workings. The nature of the walls makes it expensive to maintain the openings that would be needed for blocking out large ore reserves.

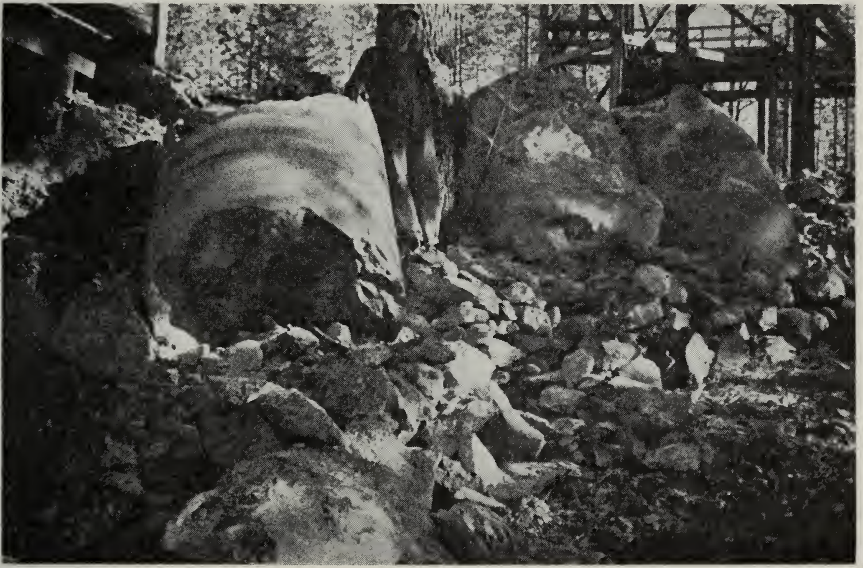
Eimco-Finlay loaders and electric haulage with 120-volt direct-current trolley locomotives and a few storage battery locomotives are used throughout the mine, the trolley trammers being made at the mine machine shop for about $300 each. Hand-cranked air drills with regular long steel are used for sinking and drifting.

The Brunswick veins occur in amphibolite schist. The vein principally worked by previous operators strikes N. 50° W. and dips from 40° to 70° SW. Work in the new shaft had reached 1347 ft. before the present company took charge. At present a number of veins are being stoped between the 490-ft. and 1300-ft. levels, and development is going on below 1400-ft. level.

Milling.

In 1939 the combined plants handled 434,514 tons of ore and concentrate, and in 1940 a total of 432,024 tons, of which about 25,000 tons annually came from the Grass Valley Bullion Mine and from small mines for which custom work was done. In 1940, there was a total of 293,005 tons of ore hoisted from the Brunswick shafts, and 113,702 tons from the Idaho shaft, but much of the Brunswick ore is brought to the Idaho mill for crushing, and separate figures for value of ore from the two mines are not given out. The average recovery value of company ore in 1940 was $11.19 a ton and tailing loss was 44.8¢ a ton.

Ironclad Mine. In SE¼ sec. 26, T. 16 N., R. 7 E., 5½ miles west of Grass Valley, near Rough and Ready. It was located in 1877 and small lots of good ore were mined yearly for several years. This ore, according to contemporary reports, yielded $20 to $42 a ton. The first shaft was sunk to a depth of 380 ft. but is now caved. The vein in it was reported 16 inches wide near the top and 2 ft. or more below, and average yield to 1879 was $35 a ton. A 5-stamp mill was on the claim at that time.



Core sections (5 ft. diameter) from Newsome shaft-boring machine at Brunswick Mine of Idaho-Maryland Group. *Photo by Walter W. Bradley*

In later years a shaft was sunk 50 ft. on a vein from 8 inches to 12 inches wide and in 1907 and 1911, the last years in which work was reported, a little $20 ore was produced. The vein is in gabbro and contains considerable sulphide.

When the older shaft was reopened in 1906 it was said that a flow of about 200 g.p.m. of water had to be handled.

Jim Consolidated is an old mine in SE¼, sec. 22, T. 18 N., R. 11 E., southeast of Graniteville. In the early 1870's it had already been in operation some time and a depth of 225 ft. on the dip had been reached. Ore near the surface is said to have yielded an ounce of gold per ton.

It had lain idle many years when Jim Consolidated Mining Company, Limited was formed in 1934 to work it. Some work has been done each summer since, being suspended in winter because of heavy snowfall. A new adit is about 1500 ft. long with a branch at a point 1000 ft. from the portal. When the district was visited in 1940 the property was idle, but the following information was supplied by a former employee: A winze was sunk 85 ft. with a drift 130 ft. east, a north crosscut 60 ft. and a drift west 70 ft. from shaft. Two small stopes are 30 ft. and 100 ft. high showing 24 inches to 30 inches of vein and an ore shoot reported from 50 ft. to 60 ft. long. During a working season of 4 months to 5 months, the 24-ton ball mill may handle 500 to 600 tons of ore, which yields about $20 a ton.

The vein is a part of the Wisconsin-Baltic system which strikes south for several miles from near Graniteville, outcropping in granite.

The heavy snows in the winter of 1937-1938 crushed several of the buildings.

La Belle and McKinley claims are on the south side of Deer Creek 3½ miles from Nevada City in sec. 9, T. 16 N., R. 9 E. The first is a full claim and the second 600 ft. by 400 ft. They lie between the Federal Loan and Lecompton mines. The vein strikes west.

La Belle claim has a crosscut adit which cut the vein 110 ft. from the portal; drifting is said to have opened a pay shoot 150 ft. long. Raises put up 50 ft. show the vein is from 6 inches to 18 inches thick. A shaft was also sunk 100 ft. deep from the drain tunnel and showed a similar width of quartz for 40 ft. and the owner believes the shoot crosses the shaft and could be picked up by drifting. McKinley claim has an adit 108 ft. long showing stringers of quartz at the face.

MINING METHODS AND COSTS OF THE LAVA CAP GOLD MINING CORPORATION, NEVADA CITY, CALIFORNIA [a]

By JOHN W. CHANDLER [b]

INTRODUCTION AND ACKNOWLEDGMENTS

The author wishes to acknowledge the valuable assistance given him by Mr. Otto E. Schiffner, Vice-President and General Manager; Mr. John F. Siegfried, Chief Engineer; Mr. Harry Morton, Accountant; and others of the Lava Cap Staff in the preparation of the subject matter and illustrations contained in this paper.

HISTORY

The property of the Lava Cap Gold Mining Corporation is located in the Nevada City-Grass Valley Mining District, about five miles east of Grass Valley, California.

At the present time, the plant is mining and milling about 390 tons of ore per day. About 310 men are employed.

Two old mines, the Banner and Central, are embraced in the present holdings of the company. The Banner Mine was first located in March, 1860, and was operated intermittently during the next five years on a small scale by various groups. The main Banner ore shoot was discovered in 1865 and the mine shipped and milled some 20,000 tons of ore, assaying between $20 and $30 per ton. This ore shoot became lean below the 600 level. Subsequent work did not open up any further ore and the mine was eventually shut down and remained inactive for a period of 26 years.

The Central Mine was located in 1861. The ledge assayed high in silver and one of the claims was worked principally for this metal. The other claims were worked for gold. The mine operated spasmodically during the next 57 years. Milling the ore was a serious problem to those early-day miners who resorted mainly to amalgamation and tests run as late as 1917 showed extractions as low as 30 per cent due to the abundance of base sulphides in the ore. The subsequent discovery of the flotation process made these base sulphide ores amenable to treatment, with recoveries of over 95 per cent.

Since 1918 no work of any importance had been done until the present company commenced operations early in 1932.

GEOLOGY

The Banner and Central veins are reverse fault fissures with subsequent quartz filling. The Banner vein strikes about due north and dips 50° to the east while the Central vein strikes about N. 25 W. and dips 51° to the NE. These veins intersect at a point some 2500 feet north of the Central Shaft where the Central vein joins the Banner vein and is apparently a split of that structure as no trace of its continuity could be found on the northwest side of Banner structure. The Banner vein, on its southern course, goes into the footwall of the

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[a] Reprinted from Information Circular 7164, U. S. Bureau of Mines, 1941, by permission of the Director. See also: Ash, S. H., Mining practices and safety at the Lava Cap Gold Mining Corporation mines, Nevada City—Grass Valley District, California; Technical Paper 619, U. S. Bureau of Mines, 1941.

[b] General Superintendent, Lava Cap Gold Mining Corporation.

Central vein. The author believes that the same major movement that created the Banner structure also formed the Central vein at about the same time. These two structures, for all practical purposes, may be regarded as of one period of movement and subsequent mineralization, although the Central vein is of much less magnitude than the Banner.

This structure has been drifted on for a length of 8000 feet. The enclosing walls are argillite, which becomes very silicious at the Banner end, due to the proximity of the contact with the granodiorite mass on the north.

Lindgren * classifies this argillite as the Calaveras Formation which belongs to the Carboniferous Age.

An igneous rock, provisionally called latite, occurs in dikes in the Central or southern end of the mine. These do not seem to have any relation to the ore shoots. They are older than the vein and serve a useful function due to this, as they often point out vein structure when following very weak fractures, since they are always cut by the vein fractures.

In the Banner, both diorite and andesite dikes have been encountered which are likewise older than the vein structure. These dikes similarly have no bearing on the ore shoots in any way.

A lava flow caps the surface on the high ground between the Banner and Central to a depth of 100 feet or more. At either end, erosion has laid bare the older series of rocks and made possible the original discovery of the veins.

Two main ore zones are recognized at the present time. One partly under the capping at the Banner and the other being the original Central Mine. Smaller occurrences of ore outside these two main zones are found, but, to date, have not proven up any large tonnages of ore.

The Banner vein is a large structure, with widths of 25 feet or more between walls not uncommon. The average width of the vein is about seven feet. Ore occurs in quartz lenses within the vein walls, also as a mass of mineralized quartz stringers within the vein filling, or both. A great deal of movement has taken place both prior and subsequent to the quartz filling. The main walls have been weakened due to fracturing behind them, allowing large slabs to form on the hanging wall. This movement has also sheared the vein filling, causing it to crack up badly while mining, necessitating heavily timbered stopes, followed closely with fill.

The ore shoots in the Banner ore zone tend to rake flatly to the north on their downward extension and are, roughly, about equal in their dimensions, measured along the strike and dip. Many large horses of waste are encountered within the vein walls and tend to split up the vein considerably. As these vein splits converge at the ends of the horses, they have a tendency to develop large bodies of quartz, which, more often than not, result in ore. Some of the highest grade ore in the mine is found at these junctions.

When ore shoots are encountered in drifting, they tend to be large and many times run up to a length of 300 to 400 feet along the strike and although the values in cut samples are extremely spotty

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* W. Lindgren's "The Quartz Veins of Nevada City and Grass Valley Districts California."

along the drift, they mine well and by careful, selective mining, a good average grade of ore can be maintained.

The Central vein at times has widths of 15 feet or more but the average is close to three feet. There are numerous horses of country rock in the vein itself, some being of considerable size, splitting the vein at times into several branches. When the vein is split up into more than two branches, due to these horses, it is rarely commercial as the values also disseminate into the various members. Sometimes one branch of these splits will have enough values left to be minable locally. When they form two branches, they both might be minable but more often, only one will be profitable.

Numerous rather flat cross-stringers are found where branches of the vein are in close proximity to each other and are a means of keeping in touch with other walls by indicating structures to prospect. This is also true within the vein walls where mining is progressing on one of several splits. This leads to prospecting of the vein to the other walls and very often discloses additional ore.

Ore shoots at the Central are not as large as the Banner and have a longer dimension along the dip. No rake of these ore shoots is noticeable. In general, it is found that a greater size of minable ore exists near the ends of the horses, where vein splits converge, than at other places along the vein. Some of the best stopes in the mine are located at such points.

Walls are more competent than those at the Banner, requiring somewhat less timbering but also require filling subsequent to mining.

In general, there is so much waste material within the vein walls themselves that selective mining and close sorting are imperative to maintain the grade of ore to the mill. The waste from this source has been used in filling the stopes.

METHODS OF PROSPECTING AND EXPLORATION

At the Banner, with the extreme widths between walls, drifting is generally done on whatever ore is disclosed when the first cross-cut is run from the shaft. In the absence of ore, the best looking part of the structure is drifted upon. Every 100 feet, cross-cuts are run to determine foot and hanging walls and the course of the drifting is set to follow commercial ore wherever possible. Drill holes every ten feet are drilled into the walls while drifting is in progress. The sludges of these holes are assayed and very often disclose ore within the walls which, were it not for these samples, would very likely be overlooked.

At the Central, due to the smaller size of the ledge, both walls can generally be kept within a heading. Drill holes are also used in the Central for sludge-sampling the walls.

After drifting along the ore zone is well under way, raises are run at the most favorable points for opening up ore shoots. Assay cuts in these raises often justify intermediate drifts and these are found to be one of the major sources of new ore discoveries.

As stoping progresses, intermediates are run at the ends of the stopes from the working floors as they are justified, either by assays or the geologic conditions becoming favorable for ore. The waste from this development can generally be utilized for fill within the stopes themselves.

Cross-cutting is done consistent with the geology in order to keep in touch with vein splits. Long cross-cuts are being driven at certain horizons to pick up additional structures. Diamond drilling has been used to check the foot and hanging walls for structures.

METHODS OF SAMPLING AND ESTIMATION OF TONNAGES AND VALUES

Sampling has two main functions: 1. Control of grade of ore sent to mill, and 2. as a basis for developing ore shoots.

Under the first heading, sampling is done at the faces of the stopes in the course of mining. In general, the amount of sulphides showing in a face is indicative of the grade of ore, the main minerals being pyrite, arsenopyrite, sphalerite, and galena.* Sulphides that lie within the quartz carry most of the values. Conversely, a lot of barren pyrite and pyrrhotite is found in the wall rocks. These samples are taken at random by the foreman and shift bosses and the assays give them control over any ore of doubtful nature.

Every stope or development heading producing ore is sampled by means of a grab sample taken by the trammers from the top of every car sent out. These samples are taken on each shift and represent the ore sent to the mill. They are of considerable help to the mill superintendent in judging whether he has a high or low mill feed coming in. The returns of these samples are entered by the office staff under the headings of the various working places. The contents of the cars in dry tons and the assay of each sample allows the calculation of the average grade of ore and gives a computed figure for each working place of the number of tons and the average grade in ounces of gold and silver for the month. Individual box samples vary considerably but over a period of a month, average very closely to the mill-feed figures. During the year of 1938, the box samples were within 1½ per cent of being correct with the mill feed.

The value of the above sampling, aside from knowing the current feed coming into the mill, lies in giving the management a figure for the average grade of ore from each stope. Individual costs are kept on each stope. These show the grade of rock that can be mined at a profit and determine whether or not a stope is profitable and to what degree. Conditions, and thereby costs, are different in every stope and by the above means, it is possible to control and mine ore close to the profit margin.

Secondly, all development faces are sampled by the foreman or shift bosses after every round. The samples are channel cuts of the vein. They are posted daily by the office staff on sheets representing each heading and the location of samples with respect to survey stations is kept. From these sheets, the average value of the vein in any heading is calculated to give average width of vein in feet and the average grade of ore in ounces per ton for any length of heading desired. These assays are plotted on plans and sections and form the basis for opening up new stopes, and, many times, indicate further development work.

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* The high silver values are due to freibergite, the silver-bearing tetrahedrite, with occasionally some ruby silver ore. J. W. C. per letter, May 16, 1941.

No attempt is made to "block out" ore in the strict sense of the term as the nature of these ore shoots is so erratic that no representative data can be arrived at. Ore reserves are figured in terms of "Probable Ore." This is defined as the normal expectancy in tons of minable ore based on the assays and judgment of the engineering department. The grade and tonnage are arrived at from the assay plans, and sections.

METHOD OF DEVELOPMENT AND MINING

The Banner Mine was opened up by dewatering the Belshaw shaft, an incline shaft following the vein, to the 800 level. The vein had been drifted on for about 600 feet by former operators. This drifting was continued south by the present operators for a distance of 2500 feet, opening up two new ore shoots.

The Central Shaft is a 51° incline shaft in the footwall of the vein and is down twelve levels to a depth of about 2300 feet on the incline. The bottom of the old workings, when the present company took charge, was at the third level. Levels have been established at intervals of 200 feet along the incline, cross-cuts run to the vein and the vein drifted upon in both directions.

An adit or tunnel has been driven from the Central a distance of 5000 feet to a point over the southern ore shoot at the Banner and serves as a main haulage for all ore going to the mill from the Banner Mine. This tunnel is the first level at the Central and arrives at the Banner as the 600 level due to the difference in elevation of the shaft collars. At a point near this southern ore shoot, another underground incline shaft has been sunk in the footwall of the vein, opening up two more levels below the 800 level. These have been cross-cut to the vein and drifts run.

Above the Banner tunnel, or 600 level, the 200-foot and 400-foot levels have been established and stoping is proceeding on the 400 level.

Ore from below the tunnel or 600 level of the Banner is hoisted through the underground Banner shaft and hauled by battery motor train to the Central shaft where it is transferred through pockets and hoisted through the Central shaft to the mill ore bins at the collar.

Drifts are driven along the vein and locations most favorable for ore are raised upon with two-compartment stull raises. These develop ore shoots intermediate between levels. They also function as second exits and enter the ventilation system of the mine.

SHAFTS

The present shafts are both 51° inclines driven in the footwall. They have three compartments in all, two skipways 4′ by 5′ and a manway 3′ by 5′. The last sinking has been done using Port Orford cedar in all wallplates, stringers, blocking, and wedges. This cedar is extremely resistant to rot and is used untreated. The dividers and posts, since they are so easily changed, are made of Oregon fir with ends creosoted; 8″ by 8″ wallplates and posts with 6″ by 8″ dividers are used. The shafts are in good country and virtually no lagging is necessary.

Pockets are cut while sinking and are timbered as one unit with the shaft. These are divided between the two skipways for ore and waste and skips are filled by use of rack and pinion gates and small swinging lips to the skips.

Shaft sinking is accomplished from the lowest level, using 1000-lb. buckets operating on skids and hoisted with a Hendri-Bolthoff air hoist. The hoisting is done thru the manway compartment, the skip compartments being bulkheaded with two sets of rock just below the skip pockets. This practice has been found entirely safe for sinking and does not interfere with the normal hoisting of ore from the level. Below the pentice, the skidways are angled across the shaft and carried down thru the middle compartment.

The sinking buckets are operated in conjunction with the conventional tail chain, trap-door system, the waste being dumped directly into the station pocket for transfer to surface with the skip. This practice eliminates transferring by car. See Figure *I-A* and *I-B*.

Headframe, Lava Cap Gold Mining Corporation, Banner Hill district, Nevada County. The buses are used to transport miners to and from work

A cycle of shaft sinking operations is as follows: Two shifts of four miners each work in the bottom and are serviced by a sinking hoistman. The drilling and blasting are done entirely by one shift and the mucking and timbering by the other. Electric blasting is used and relatively little water is encountered. This is handled by a high-lift sponge pump. The drilling crew picks and cleans up the bottom, drills a 36-hole round to a depth of 6 feet and blasts. The other shift comes on four hours after blasting time. They hang and block a set of timbers and muck an average of 110 ten-cubic-foot buckets. For a month at a time, the crews will average about 5 feet, or a set a day. Gardner-Denver D-79 Light Drifters are used as sinkers with two men to a machine. A standard ''V'' cut shaft round is used and blasted with 45% Gelodyn powder. Mucking is all hand work. One inch Quarter Octagon High-Carbon Drill Steel is used with the shank end upset to $1\frac{1}{4}''$ round and lugged. Cross bits are forged.

DRIFTS AND CROSSCUTS

These headings will average about 5′ by 7′ in size and are mostly hand-mucked. Mining is done on one shift and mucking on the other. Pyramid-cut rounds tend to break the best with about a 16 or 17-hole round loaded with 110 sticks of 45% Gelodyn powder. An average break will be close to 4½ feet. In some of the drifting, Model 11 EIMCO-Finlay loaders are used and where the distance from the shaft is great, battery-motor haulage is found economical. Where shovel-loaders are used, longer drift rounds are drilled. The use of burn cuts has increased the footage considerably and the extra muck is easily handled with the loaders.

It is necessary to maintain a switch within 300 feet of the face on the longer headings. A "cherry-picker" has been successfully used which can pick up a loaded car and swing it to one side, allowing the motor and empties to go by. In the use of this device, a whole train load of cars can be loaded out before the motor takes a trip to the dump. The cherry-picker can be set up in a space cut in the side of the heading 5 feet wide, 10 feet long, and 9 feet high. It saves the use of switches and the necessary sideswiping for siding track.

Both Gardner-Denver D-79 and D-89 drifters are in use. Steel used is 1¼″ round high carbon lugged with cross bits.

RAISES

These are generally two compartment, 5′ by 10′ in size, and are generally stulled in the center with the chute side lined. (Both end-cut and "V" cut rounds are used.) Two men on a shift form a raise crew and, due to gas not clearing out quickly enough, the raises are generally run on one shift only. The cycle of work after timbering depends, in the main, on ground conditions but ordinarily three or four rounds are shot before timbering is resumed and bulkhead moved up. (Chicago-Pneumatic CP-43 stopers are standard for this work.)

MINING (STOPING)

Three classifications of stoping are used. In order of their importance, they are:

1. Cut and fill.
2. Square sets with fill.
3. Open stopes with pillar support.

The bulk of the ore is mined by the first two methods with variations. Various methods have been employed to maintain a good grade of ore to the mill by very close sorting. One of the best sorting systems in use is the "stringer" set. These sets are 8″ by 8″ stringers with round posts set at 5′-6″ centers and 3″ by 12″ lagging, doubled when shooting upon it. This works out well where walls are competent to stand open for two floors but in heavier ground conditions, it is replaced by square sets and fill.

Where the vein is narrow and stoping is done by stulls, sorting is a problem. The narrow ledge makes a working floor very crowded to work. Under these circumstances, a modification of the stringer set system is used. Instead of stringer sets on each floor, they are only established every 40 or 50 feet up the stope. Enough footwall is shot out to make working room and the floors are laid. Stoping progresses upward on stulls. The muckers have room to work on the floor and can sort the ore clean, sending the waste thru the floor to the open stull section being gobbed below them. At times, it is necessary to remove some of the lean vein in opening up the ore and this can be done by removing the flooring where this material is being blasted and allow it all to go into the gob below without having to handle it. This system works out admirably in some parts of the mine.

At the Banner Mine, the square set and fill is in use, due to the badly sheared vein and weak walls. To a lesser degree, stringer sets are used, depending largely upon wall conditions. It has been found that as far as wall support is concerned, stringer sets are almost worthless and may be considered a glorified staging, strong enough to withstand the shock of blasting and facilitate the mucking and sorting of the ore.

The third method is largely in use in the narrower lenses of ore in the Central and is used in the clean up of small sections in the top portion of the mine after the biggest part of the ore has been mined. It is necessary to mine very clean and not allow any unnecessary dilution to creep in. Sorting is also done in these stopes as far as it is possible. Gob is held in cribs or run into mined-out sections.

All stoping is laid out so that supplies are readily accessible thru raises from the levels. These are handled in steel boats on slides by means of tugger hoists. Waste from the vein itself is not always available in sufficient quantities to fill the stopes and it is necessary to maintain raises and transportation facilities to handle waste into the stopes where necessary. Waste-raise passes are maintained in line from level to level in order to transfer waste from various development work above to the levels requiring it for stope fill below.

Light drifters are generally used in stope work where a bench is carried in horizontal cuts. By blasting with flat holes, an ore pile can be shot on a floor without scattering, and the waste can be sorted behind the cut without danger of ore fines being lost after the next blast in the waste piles previously sorted out.

As floor cuts are started from raises, waste is brought in behind the cut by means of ten cubic-foot cars and sectional steel track using 8-lb. rails. In some of the square-set filling, standard concrete buggies are found to serve better than cars, since they can be trundled thru a square-set section without laying an elaborate system of tracks.

Chutes are carried by stulls with gob lagging in the small stopes. In the larger cut and fills, they are carried wall to wall by stulls for the first 40 feet in order to serve as pockets and thereafter carried with 3″ by 12″ cribbing.

This is readily adaptable, either as a single chute or a chute and manway.

In the square sets, chutes are carried within the sets themselves. These are lined with 3″ by 12″ and gob lagged on the outside. The tops of all chutes have 8″ grizzlies, formed either by timbers or rails.

Various methods of timbering are used in starting stopes from level sills, depending on ground conditions. The most simple is the stulls with pole sheeting between chutes. Where the footwall tends to slough out and the hanging wall is fairly good, a combination of stulls with posts along the footwall side of the track is used. The footwall is then lagged up and held secure while the post helps support the stull near the hanging wall. Where the ledge is wide, sets are stood with caps framed wall to wall and sheeting of poles used. In the heaviest ground conditions where the main walls are not competent and the widths of the vein great, large sill square sets are used with bridge caps, which are sheeted.

UNDERGROUND TRANSPORTATION

A standard chute set and gate are in use. This was developed due to the previous high cost of putting up chutes. It was found that much time was consumed in putting up a chute when men tried to cut and fit the timbers according to the amount of ground shot out. In most cases, the chute could have been constructed better if the men could have blasted out a little more room for loading and headroom. If they proceeded to do this, much time was consumed in plugging. A standard chute set was drawn up and when a chute goes in, a standard amount of ground is shot out to make room for it. Timber is all framed on top and fits together rapidly. The chute sides come down intact and only have to be spiked in. The chute gives a trammer room to pull it. The steel gate is safe to operate by means of a handle and many accidents prevalent with the old stop-board chutes opened by hand have been eliminated.

Hand-tramming is resorted to on all levels except where ore is transferred from one level to another to eliminate long hand trams and is then handled by small 1½-ton battery motors. Double duty is performed by these motors in returning waste from the shaft to the stopes for filling.

Ore is hauled from the Banner Shaft to the Central Shaft some 5000 feet by means of 4¼-ton battery motors and 30 cubic-foot rocker-bottom cars in trains of 15 cars to a trip.

In the Central Mine, 18 cubic-foot end-dump cars are in use, both with small motors and in hand-tramming.

Pockets at the shafts are limited to about 75 tons capacity and are formed by cutting the pocket integral with the shaft and timbering it.

Skip dumps are the Angrove type, used largely in the Michigan Copper Country. Over-wind trips are set in the dumps which cut the power and apply the brakes if the skip travels too far through them. Electric indicators in the hoistroom show whether the dumps are set for ore or waste and these are operated by oil and air from the hoistroom controls.

Enough waste for stope fills has always been a problem. There was always plenty of it from new bottom development but not enough in the top development to do the job. At the Central, a skip was developed that would hook on under the regular skip. Handwheels control a dumping mechanism which allows the bottom to swing out, similar to a steam-shovel dipper, deflecting the discharge into the footwall pocket. This solved the caging problem of the waste as it permits waste either to be hoisted or lowered to a point in the shaft where it can be discharged into a 75-ton storage pocket in the footwall of the shaft and from there be transported back, by the small battery locomotives, on the level to be used for stope fill. When not in use, this skip is stored on the station of an obsolete level. A hand trip was used to dump the skip because of fear that an automatic device might cause an accident in the shaft. This skip can service a level with waste and this waste can be transferred by raises through two or three levels to whichever stope requires it. When the cost of the transfer of this waste becomes too great, another footwall pocket will be cut in the shaft and the same skip used to deliver waste to that point with the same scope of distribution that the present setup enjoys.

Five by six guides are used in the Central shaft between each set of rails and shoes on the skip axles ride the guides in case of derailment. It also prevents a wreck from a skip jumping the rails on its up-trip and nosing down under a footwall plate with a wheel, thereby dumping the skip in the shaft.

A Nordberg 300-HP hoist is used at the Central shaft, with a rope speed of 1000 feet per minute and an Allis-Chalmers 150-HP hoist, with a rope speed of 600 feet per minute, at the underground Banner shaft. These are equipped with Lilly and Simplex controls respectively.

A 100 per cent extraction is maintained in stoping work. The dilution by waste is a big problem and upon it depends the mill grade. The degree of sorting varies with the grade of rock mined and, in some stopes, is done very painstakingly, while in others with comparatively low-grade ore as a whole, it does not pay to sort too closely. Sorting is purely an economic problem, with each stope presenting a different setup. In general, it might be said that 20 per cent of all fill used in the stopes is sorted-out material. It has been considered uneconomic to sort waste out on the surface.

WAGE, CONTRACT, AND BONUS SYSTEMS EMPLOYED

Wages paid are as follows:

Miners and Timbermen	$5.84
Muckers	5.36
Skiptenders	6.00
Hoistmen	6.72
Trammers	5.36
Motormen	5.84
Switchmen	5.36
Nippers	5.84

A contract bonus system is used in most development work. Any particular heading is paid a price per foot, which includes all the mining, mucking, and powder. In raise and shaft work, and to a lesser degree in drifts, the labor required in timbering is included in the price.

The price paid in any heading is based upon what standard of work the management expects in that heading. When the original prices on the work were set, current wages were $5.25 for miners and $4.75 for muckers. Since wage scales have changed from time to time, the above scale is used in the computation of all contract prices. For example, a drift is being driven by hand-mucking where the management would expect a crew on company time to average 3.50 feet per shift with a miner and mucker on each shift. From experience, it is found that this ground will use 25 sticks of powder to the foot advance.

A crew on company time will then advance 3.50 feet for the following cost:

One miner	$5.25
One mucker	4.75
3.5 feet by 25 sticks equals 87.5 sticks powder	
87.5 @ 4¼¢ per stick	3.72
	$13.72

$$\frac{13.72}{3.5} = \$3.92$$

and is usually raised to an even figure of, say in this case, $4.00 per foot.

At the end of a month, bonus measurements are made by the engineers and bonuses are computed using the shifts at the base-wage scale. The bonus made is converted into the amount per shift over wages at the base scale and is added to wages at the present scale. This obviates the necessity of refiguring contract prices whenever a change of wages takes place.

The contract sheets are figured and posted on the bulletin board on the 5th of the month so that the contractors can review them and call any errors or oversights to the attention of the office. Any corrections or errors can then be rectified and, after a day or two, the sheets are removed and checks are made out to cover the bonus earnings.

VENTILATION

The Central Mine is some 1800 feet deeper than the Banner and is ventilated by means of a 20,000 cubic foot per minute reversible Sturtevant Blower, located about 500 feet in the tunnel, between the Banner and Central mines. It is operated as an exhauster under a 1″ water gauge.

The Central shaft is downcast and by means of the necessary doors and stops, the air is well distributed and returns through raises to the tunnel.

The Banner Mine has natural ventilation by means of the tunnel.

Concrete and steel fire doors are located at strategic points to cover possible fire contingencies. One-hundred gallon drums, filled with water, and fire buckets are placed near all shaft stations and timber areas to facilitate putting out small fires. These drums are piped with water and are equipped with standard water hose spuds.

FIRE CREW ORGANIZATION

Two mine rescue crews are trained by the U. S. Bureau of Mines and receive monthly helmet practice.

The Lava Cap Gold Mining Corporation is a member of the Cooperative Mine Rescue Station, located in Grass Valley. This station is equipped and maintained by four of the larger mining companies in the district for mutual protection in the case of disaster. It contains eleven McCaa 2-hour oxygen breathing apparatuses and five all-service gas masks and other necessary equipment.

FIRST-AID AND SAFETY ORGANIZATION

The men at the Lava Cap Gold Mining Corporation are 100 per cent trained in First Aid, given by the U. S. Bureau of Mines yearly.

Once a month, each shift meets at a Safety meeting, conducted by the Safety Engineer. Each shift elects a safety committee of three men by popular vote. These men are elected in rotation every two months. The newest member takes his place as the chairman retires. The oldest man on the committee automatically takes the chair. This procedure insures the committee of having a chairman who has served four months and, consequently, is the man most qualified to handle the committee. Four such committees are constantly maintained, two at the Banner and two at the Central, representing each shift. Their periodic inspection trips are so timed that the entire mine is fully covered by an inspection every two weeks. These committees make a list of suggestions which they discuss with their respective foremen as to the advisability of making necessary corrections. The foremen then proceed to rectify any conditions or practices that are suggested. At the following Safety Meeting, the reports of the committees are read and the foremen state what disposition has been made on each suggestion.

After the report of safety committees, safety suggestions are called for from the floor and many valuable suggestions have been offered.

In addition to this, an executive inspection is made of the whole mine, both surface and underground, every 60 days by the General Superintendent, Safety Engineer, and both mine foremen, accompanied on the surface inspection by the Master Mechanic and Mill Superintendent.

The Safety Engineer has a splendid opportunity to take up a regular program of safety education with the men and to teach them to think along safe lines.

It has long been recognized that the accident experience varies directly with the class of workers employed. For this reason, the Lava Cap goes to some lengths in the proper selection of men. An employment office is located near town so as to be convenient for this purpose. Hiring is done three times a week by the Safety Engineer and every man applying for work is interviewed. After each interview, the man is either told that he can not be considered for employment for satisfactory reasons or he is asked to return at the next regular hiring day for a definite reply as to his chances for employment. The last request is made to enable the Safety Engineer to gather a group of likely-looking men together and study their adaptabilities. From this group, he can select the best to meet the current needs for replacements. When the hiring day arrives, he selects the men he wants and lets the rest of the men on the list go. The men selected as desirables are sent in to the examining physician.

When a man returns from the doctor's office with a satisfactory report, he is given a Rustling Card, which is good for three months. No promises or commitments are made except that any man who has secured a Rustling Card will go to work in a reasonably short period of time. The men holding Rustling Cards are only sufficient in number to cover current needs. It is found that when this is adhered to, men will stay seeking employment because they know that they will not have to wait very long to go to work.

No men are ''led along'' waiting for jobs. At times when the turnover is small, it is necessary to tell men that the chances of employment are not too good and ask them to return in a short period of time. This treatment of men develops a confidence between the men and

Safety Engineer and leads to their doing as he asks. These men who are well fitted for work are given a chance to obtain a card when they return again, providing the rustling line is not overcrowded. All things being equal, preference is given to old employees.

This line of approach has been very successful. It is recognized that this is the closest outside contact with men who are not actually employed by the company. By virtue of this fact, the approach to the men is maintained as pleasantly as possible and care is exercised that men who are refused employment do not leave bearing an ill feeling toward the company.

Men who are working under good conditions advertise to others. The best men in the mine are acquainted with other good men who attempt to gain employment. By close selection of this group, a better-than-average crew is maintained and the work efficiently done.

I—A. SUMMARY OF COSTS

Name of Mine: *Central Mine* Period Covered: *Year 1939*
Tons of Ore Hoisted During Year: 60704
Mining Method: Cut and Fill

Underground Costs per ton ore hoisted:

	Labor	Supervision	Compressed air drills and steel	Power cost	Explosives	Timber	Other supplies	Total
Development	$0.841	$0.044	$0.124	$0.013	$0.291	$0.033	$0.137	$1.483
Mining (Stoping)	1.801	0.095	0.212	0.034	0.183	0.203	0.264	2.792
Transportation (Underground)	0.362	0.019	—	0.055	—	—	0.053	0.489
General underground expense	0.207	0.012	—	—	—	—	0.033	0.252
Surface expense (Directly applicable to underground)	0.372	0.023	—	0.008	—	—	0.067	0.470
Totals	$3.583	$0.193	$0.336	$0.110	$0.474	$0.236	$0.554	$5.486

I—B. SUMMARY OF COSTS

Name of Mine: *Banner Mine* Period Covered: *Year 1939*
Tons Ore Hoisted During Year: 55676
Mining Method: Square Sets with Filling

1. Underground Costs per ton ore hoisted:

	Labor	Supervision	Compressed air drills and steel	Power cost	Explosives	Timber	Other supplies	Total
Development	$0.874	$0.046	$0.107	$0.024	$0.207	$0.099	$0.141	$1.498
Mining (Stoping)	1.711	0.089	0.162	0.058	0.083	0.308	0.271	2.682
Transportation (Underground)	0.440	0.024	—	0.056	—	—	0.073	0.593
General underground expense	0.141	0.008	—	—	—	—	0.023	0.172
Surface expense (Directly applicable to underground)	0.427	0.027	—	0.006	—	—	0.083	0.543
Totals	$3.593	$0.194	$0.269	$0.144	$0.290	$0.407	$0.591	$5.488

II—A. SUMMARY OF COSTS IN UNITS OF LABOR, POWER AND SUPPLIES

Central Mine—Tons Ore Hoisted 60704 *Year Covered—1939*
Mining Method: Cut & Fill Stoping

	Development	Mining (Stoping)	Total
A. Labor (Man hours per ton ore hoisted)			
Breaking (Drilling and blasting)	.489	.706	1.195
Timbering and filling	.060	.473	.533
Mucking	.373	1.177	1.550
Haulage and hoisting	.112	.331	.443
Supervision	.073	.190	.263
General	.231	.580	.811
Total labor underground	1.338	3.457	4.795
Average tons per man-shift	5.726	2.354	1.668
Labor, per cent of total cost	65.10%	71.71%	69.48%
Average tons per man-shift on surface (Properly chargeable to underground operation)	43.731	21.867	14.578
B. Power and Supplies			
Explosives (pounds per ton ore hoisted) Gelodyn No. 3 (45% volume strength)	1.217	1.747	2.964
Timber (B. M. per ton ore hoisted)	.791	7.120	7.911
Poles (Lineal feet per ton ore hoisted—Size, 8″ to 16″)	.221	.977	1.198
Total power (K.W. Hrs. per ton ore hoisted)	11.294	25.761	37.055
1. Air compression	6.314	11.472	17.786
2. Hoisting	2.057	7.169	9.226
3. Pumping	1.725	4.204	5.929
4. Ventilation	.356	.867	1.223
5. Lighting	.302	.736	1.038
6. Shops (Portion chargeable underground)	.421	1.024	1.445
7. Battery charging sets (Haulage)	.119	.289	.408
Other supplies in per cent of total supplies and power	31.09%	38.65%	35.65%
Supplies and power, per cent of total cost	31.98%	24.99%	27.35%
Compensation insurance, assaying, per cent total cost	2.92%	3.30%	3.17%
C. Per Cent of Total Cost	33.69%	66.31%	100.00%

II—B. SUMMARY OF COSTS IN UNITS OF LABOR, POWER AND SUPPLIES

Banner Mine—Tons Ore Hoisted 55676 *Year Covered—1939*

Mining Method: Square Sets with Filling

	Development	Mining (Stoping)	Total
A. Labor (Man hours per ton ore hoisted)			
Breaking (Drilling and blasting)	.416	.446	.862
Timbering and filling	.162	669	.831
Mucking	.272	1.116	1.388
Haulage and hoisting	.160	.375	.535
Supervision	.060	.156	.216
General	.212	.555	.767
Total labor underground	1.282	3.317	4.599
Average tons per man-shift	6.016	2.447	1.740
Labor, per cent of total	67.12%	71.09%	69.67%
Average tons per man-shift on surface (Properly chargeable to underground operation)	40.109	20.056	13.370
B. Power and Supplies			
Explosives (Pounds per ton ore hoisted) (Gelodyn No. 3, 45% volume strength)	1.259	.454	1.713
Timber (B. M. per ton ore hoisted)	2.384	8.968	11.352
Poles (Lineal feet per ton ore hoisted—Size, 8″ to 16″)	.459	2.059	2.518
Total power (K.W. Hrs. per ton ore hoisted)	7.873	12.847	20.720
1. Air compression	2.592	4.245	6.837
2. Hoisting	2.449	1.633	4.082
3. Pumping	1.868	4.597	6.465
4. Ventilation	.186	.456	.642
5. Lighting	.233	.575	.808
6. Shops (Portion chargeable underground)	.156	.383	.539
7. Battery charging sets (Haulage)	.389	.958	1.347
Other supplies in per cent of total supplies and power	32.39%	38.00%	35.79%
Supplies and power, per cent in total cost	30.03%	25.58%	27.17%
Compensation insurance, assaying, per cent of total cost	2.85%	3.33%	3.16%
C. Per Cent of Total Cost	35.53%	64.47%	100.00%

III. DETAILS OF COSTS IN UNITS OF LABOR, POWER AND SUPPLIES

DEVELOPMENT

	Sinking	Cross cutting	Drifting	Raising	Total all development
Size of headings	7 x 14	5 x 7	5 x 7	5 x 10	
Timbered or not	Regular shaft sets	None	Small amount	Stulls with lining	
Physical properties of rock	Hard	Hard	Medium to soft	Medium	
A. Labor (Man hours per foot)					
1. Breaking (Drilling, and blasting)	7.258	2.588	2.043	3.989	2.512
2. Timbering	3.633	.093	.149	2.487	.603
3. Mucking	6.311	2.388	1.933	.120	1.768
4. Haulage and hoisting	2.832	1.353	.948	1.863	1.165
5. Supervision	.415	.422	.339	.557	.382
6. Total labor	20.449	6.844	5.412	9.016	6.430
7. Average feet per round	4.72	3.73	4.26	4.55	4.27
B. Power and Supplies (per foot)					
1. Explosives (Pounds per foot)	18.930	12.632	8.271	7.333	8.647
2. Timber (Per foot)					
a. Poles (Lineal ft.)	0.	0.	.18	2.52	------------
b. Sawed (B. M.)	137.00	0.	.63	24.87	------------
3. Total power (K.W. Hrs. per ft.)	146.849	78.845	50.270	53.712	54.859
a. Air compression	87.741	27.820	24.357	22.721	25.752
b Hoisting	32.728	11.468	11.476	16.389	12.752
c. Pumping	12.173	31.007	8.699	8.361	10.189
d. Ventilation	3.449	2.372	1.456	1.443	1.559
e. Lighting	3.382	2.327	1.428	1.415	1.529
f. Shops (Portion chargeable underground)	3.758	2.584	1.586	1.572	1.669
g. Haulage (Battery charging sets)	3.618	1.267	1.268	1.811	1.409
4. Other supplies, cost per ft	$7.79	$0.78	$0.72	$1.20	$0.97
C. Labor Per Cent of Total Cost	66.74	63.96	63.96	64.82	64.52
D. Power and Supplies, Per Cent of Total Cost	28.36	30.99	30.45	29.62	30.02
E. Compensation Insurance, Assaying, Shops, Per Cent of Total Cost	4.90	5.05	5.59	5.56	5.46

Milling. (Lava Cap Gold Mining Corporation)

At the time of visit, (October, 1940) there was a strike at Selby smelter which for many years has been the principal outlet for sulphide concentrate from gold mines in northern California. No company was more inconvenienced by this strike than the Lava Cap, where an accumulation of concentrate containing several hundred thousand dollars in gold and silver was piled up before the smelter resumed work.

To forestall a repetition of this, an up-to-date cyanide plant was under construction and some of the units were being tested in October. It has since been completed and is being operated experimentally but not yet at full capacity.

The mill handles from 350 to 410 tons of ore a day, producing from 20 to 22 tons of concentrate. After passing through the primary jaw crusher and over a magnetic pulley the ore goes by belt conveyor to a vibrating screen. Fines pass by belt conveyor to Allis-Chalmers Superior crushing rolls ($15\frac{3}{4}''$ by $43\frac{1}{8}''$). Coarse ore goes to a gyratory crusher and by elevator to rolls. Thence fine ore goes to a Marcy ball mill which discharges to a trommel screen; fines from screen pass to a

Denver sub-A unit cell which gives a finished concentrate. Coarser feed over screen goes to a Dorr double classifier, which sends coarse portion to a Hendy ball mill handling about 100 tons daily. Ground pulp and fines from classifier pass to 2 Mineral Separation flotation cells making concentrate and 6 M. S. cells making a middling product. Middling goes to 2 cleaner cells. Tailing passes to 2 cleaner cells and to a jig, from which the product is sent back by Frenier pump to the classifier. The jig tailing goes over a concentrating table which saves a ton of concentrate in 4 or 5 days. A thin line of scheelite shows on this table but was not being saved separately at time of visit. The flotation concentrate was being pumped to a tank and thence by 2 diaphragm pumps to the cyanide plant, during experimental and ''breaking in'' work. The gold in this ore is fine, and practically all of it is said to pass through 400-mesh screen. It is only rarely that ''high grade'' ore occurs. The percentage of silver is so high that the mine is one of the leading silver producers of the state, besides being the third largest gold producer in Nevada County. Silver output has been as high as 300,000 ounces in a year, due to notable amounts of freibergite in the ore, with occasional ruby silver crystals. In 1939 when over 116,000 tons of ore was milled, an ore treatment cost of 75.4 cents a ton and a realization cost of $1.20 a ton was reported.

The cyanide plant contains 2 tube mills, 6 thickener tanks, 8 agitators, Western Machinery bowl classifiers and rakes, pumps for semi-pregnant and pregnant solution, sand, precipitation and vacuum pumps, Bendelari diaphragm jigs, etc., with improved electric control of operation.

Liberty Group, containing 70 acres of unpatented claims on Poorman Creek about ½ mile southeast of Graniteville, has been worked recently by Jas. E. Robertson and 4 associates. The latest work has been ground sluicing on a bar of Poorman Creek. An area of about ¼ acre had been worked to bedrock, about 12 ft. deep, when visited in June, 1940. A large number of heavy granite boulders have to be stacked and for this a hoist and a series of blocks are used, power being furnished by a Buick automobile engine. A small amount of coarse gold is saved in sluice boxes.

Quartz veins also occur on the claims and considerable work has been done in the past upon them. The Liberty vein was opened by an old adit 300 ft. long and 200 ft. of south drift, as well as an old vertical shaft 100 ft. deep. The Maggie vein, 40 ft. west of Liberty vein, had an adit 70 ft. with 50 ft. of drift on vein and an old shaft 60 ft. deep. Some production is claimed to have been made years ago. Recently in a 51-ft. shaft on the Liberty vein, Robertson states 6 tons of ore yielded 2 oz. gold. The vein is 12 inches thick here. He has placed an old 4-stamp mill at this shaft in preparation for more work. The three veins strike south in granite.

Maben Hill Mine is in NW. ¼, sec. 16, T. 14 N., R. 8 E., 1½ miles southeast of Limekiln school. Work has been carried on at intervals since 1934. In 1935 a mill with a capacity of 8 tons a day was in operation for a short time. When visited August 21, 1940, the mine was idle and deserted, with water in the shaft to within about 50 ft. of the top. The only equipment in sight was a small pump and steel water tank. News items indicate that some ore was milled in 1935, with 4 men employed.

Marsman Company of California in 1939 took a diamond-drilling outfit to Meadow Lake district and put down 7 drill holes to prospect the Great Western, Great Eastern, Excelsior ''O'' vein, Excelsior ''X'' vein, the Fraction claim and the Excelsior veins below the old Hartley workings.

In a report to J. O. Enberg, president of the company, George H. Newman, the company's geologist, stated in part as follows:

''Of the 7 holes drilled, 4 were negative in results, 1 was encouraging and 2 mildly so. The results of drilling do not substantiate the original representation of the Meadow Lake orebodies as being large well-defined veins of great strength and resistance with possibilities of producing large tonnages of medium to low grade ore . . .''

In the 32nd report of the State Mineralogist, pages 189-204, A. L. Wisker reviewed the much-debated subject of the possibilities of Meadow Lake district, and the reader is referred to his article for further information.

Mt. Vernon (Home or Native Son). It is 6 miles north of Nevada City in sec. 20, T. 17 N., R. 9 E. Considerable work has been done in the past but there is little record of production. An inclined shaft has been sunk about 400 ft. with levels reported at 220 ft. and 400 ft. On 220-ft. level a drift was run east 100 ft. and a crosscut was run 75 ft. to the Swede vein. On 400-ft. level is a crosscut 75 ft. long and a drift 30 ft. on the Old Home vein. A drain tunnel has been run 1900 ft. from the slope south of Yuba River and will give drainage to an inclined depth of several hundred feet below present shaft bottom. This work was done at different times between 1900 and 1913. In 1909, a few tons of $10 ore was milled. In 1938, a lease was given to Thomas Brown who reported saving $53 from 3 tons crushed in an arrastre.

The veins occur in granodiorite and are reported to range from 6 inches to 3 ft. in thickness.

Normandy-Dulmaine. These claims were described in detail in the 1918 report and later work was mentioned in the 1930 report. The claims are near the Alcalde in Deadman's Flat district and in 1933 they were under the control of Mattie Gold Mines Company, but this outfit did no new work.

The Dulmaine vein stands nearly vertical and strikes N. 25° W. The deepest shaft, 350 ft. deep, was sunk on it. The fissure was as wide as the shaft in the upper levels but the quartz is only 12 inches to 18 inches wide. The Normandy vein, parallel in strike to the Dulmaine and 700 ft. east of it, has 2 branches 40 ft. to 50 ft. apart on the northern part of the Normandy claim, and these dip 35° W. and 65° W., diverging at increased depth. Besides the shallow workings about 1900 ft. of drifting on the Normandy vein is reported from the Dulmaine shaft. No orebodies were found, so far as known. The country rock is amphibolite schist. Still another vein called the West Normandy, crosses the veins mentioned on the south end. This strikes east and dips north.

Like the other claims in this district, these produced good ore from shallow workings but the amount is not definitely known; $100,000 output is claimed.

Northern Bell and Thomas patented claims are on the south end of Osborne Hill, adjoining the claims of the Goodall Consolidated on the south in secs. 1 and 12, T. 15 N., R. 8 E. This property was worked a short time in the 1880's. An item published in June 1882 indicated that 66 tons of ore was taken out daily in the latter part of May, 1882, and that $33,706.39 was produced in May up to the 25th. No further reference can be found. A shaft is said to have been sunk 130 ft. and 2 tunnels between 100 ft. and 200 ft. were run on the Northern Bell claim, which contains 11.99 acres and lies southeast of the Thomas claim (9.18 acres). The country rock is diabase.

Oakland Claim. Located 2½ miles southeast of Grass Valley, in sec. 1, T. 15 N., R. 8 E., in the Ophir Hill-Osborne Hill area; elevation 2800 feet. Owner, Mrs. _____ Hofheinz, San Francisco. Patented. The history of the Oakland claim is one of intermittent operations from the early 1850's to 1890. The production during that time is claimed to have been about $90,000. A vein with northerly strike, average dip 40° W., and width from a few inches to 2½ feet outcrops the length of the claim. The fissure is well defined and the ribbon quartz it contains is typical of the district. No recent development work has been done.

Ocean Star Mine is 2 miles east of Washington on the south side of Yuba River. The last previous operations were between 1914 and 1918. The ore milled during that period yielded from about $3 to $11 a ton. The last work was done by Columbia Consolidated Mines which held the mine and several others nearby, and the exact figures of production are uncertain, but the best ore was milled in 1914 and 1915, the larger part of it yielding about $5 a ton (gold priced at $20.67 an oz.).

The shaft was sunk 300 ft. When unwatered in June 1940 by Elmer R. Berg and associates of Reno organized as Columbia Star Gold Mines, Inc., it was found that besides the mining of ore above the 100-ft. level, stoping had been carried 30 ft. above the 200-ft. level, leaving 60 ft. of backs. The drifts on 200-ft. level extend 40 ft. north and 120 ft. south. The ore shoot rakes south, according to Clark Waite, and the shaft is claimed to pass out of it between the 200-ft. and 300-ft. levels. No drifting has been done on the 300-ft. level to check this, but between these two levels the quartz in the fissure is said to pinch to 6 inches with 5 ft. to 6 ft. of filling.

The German adjoining on the south, and the Columbia claims are included in the holdings leased to the above company.

Prudential (Selena, Perrin & Co. or Slate Ledge). The earliest available record of work here indicates that production started late in 1867. The mine was then called the Selena. By the middle of 1868, an incline had been sunk 125 ft. on the vein and it was said that production had been going on 8 months. By January, 1869, a total of 1001 loads of ore had yielded $23,000, averaging about $30 a ton. The incline was then 370 ft. deep, and 8 men produced 16 tons of ore a day. In October, 1869, it was stated that $11,200 was produced at a total cost of $2,058. The following fragmentary record of output came from contemporary news items:

Jan. 1873	4 days' run gave $1,377 on plates
Oct. 1873	10 men in 3 weeks $1,600
Dec. 1873	$5,000 in gold from ore costing $900 to mine and mill
July 1874	28 loads yielded $572 free gold on plates alone
June 1883	17 loads yielded $2,482
Mar. 1884	73 loads yielded $2,301
June 1884	42 loads yielded $2,184
Jan. 1887	24 loads yielded $816

In 1890 produced $5,000
In 1891 produced $13,104
In 1893 produced $24,500

In the last period of operation, 1909 to 1912 inclusive, 1170 tons yielded only $5,141.

The mine which is in the canyon of Wolf Creek, 5 miles south of Grass Valley, was opened by an adit 1793 ft. long. The vein strikes east and dips 30° S. It lies in slate and greenstone to within 200 ft. of the face of the adit where it enters granodiorite. Ore was stoped for a length of about 1000 ft. above the adit level. At a point 793 ft. from the portal, an inclined winze was sunk 347 ft. and levels were run east 954 ft., 636 ft. and 540 ft. by 1896 and a west drift was 200 ft. long in 1904. The work done since is not known. Below the adit the ore shoot is said to have forked into several small branches, raking west. The width of vein has varied from 4 ft. in the upper levels to 18 inches in the bottom. Concentrate, largely arsenopyrite, forms 3% to 6% of ore and is low grade. There was a 10-stamp mill ½ mile from the adit.

Reward Mine. This is on the eastern branch and near the south end of the Reward-California-Gold Tunnel-Pennsylvania vein. While the California and Gold Tunnel mines were opened at very early dates, the development of the Reward was delayed until the 1890's. In 1893 the inclined shaft was only 150 feet deep. In sinking it, so much water was encountered that it was decided to run a drain tunnel. This was run from Deer Creek a distance of 2,400 feet and was the 400-ft. level. Sinking was then resumed and early in 1898 reached an inclined depth of 700 ft. A 2-stamp mill was put in operation. In February, 1898, they cleaned up $6,000 from ore that yielded $27 or more a ton. The thickness of vein was reported from 7 inches to 12 inches. On the 500-ft. level it was said to have been 9 inches thick and to have carried a streak composed of 60% sulphides which assayed $225 a ton. This was shipped to a smelter. Usually the sulphides formed 4½% of ore and assayed $180 to $200 a ton.

Rusty Claim. In SE. ¼, sec. 21 T. 18 N., R. 13 E. in Meadow Lake district. L. C. Jackson, R. 7, Box 4424, Sacramento, reported that in 1935 he operated a Tetrault mill on ore from this claim and sold a few hundred dollars worth of gold. So far as known this is the only recent gold production from that district.

Spanish Mine. Owner, San Francisco Commercial Company, 1022 Crocker Bldg., San Francisco. Three miles north of Washington. This old mine, known as the place where the late F. W. Bradley and P. R. Bradley gained early experience and made a good record in the cheap handling of low-grade ores, has been described often in our reports. Since the 1930 report, a great deal of work has been done.

A selective flotation plant of 50 tons capacity was put in operation in April, 1931. This was operated for nine months[1] on ore from No. 4 and No. 16 tunnel stopes, which "ran from $3 to $6 in gold, 2 to 3 oz. silver, 0.6% copper, 1.5% lead and 2% zinc. Five different concentrates were produced: copper, lead, zinc, iron and barite." Mine work stopped in November, 1932, but was resumed in 1933. No. 16 tunnel (elevation 3,022 ft.) was extended to a length of 5,676 ft. northward on the vein and No. 4 tunnel, 255 ft. above No. 16, is 1,803 ft. long. The mill tunnel at the old Spanish pit workings 580 ft. above No. 4, runs 689 ft. north.

According to Harden, from whose article these notes are summarized, an orebody averaging 0.26 oz. gold and 3.5 oz. silver was developed at the Barite Mine which is 8,500 ft. north of and 1,500 ft. above No. 16 portal. (See our 1930 report.) An aerial tram was built in 1933 to bring this ore to the mill and a 50-ton cyanide plant was put up and began treating the oxidized ore in October, 1933. When fresh sulphide ore was found at depth, a combination of flotation and cyanidation was used, as shown in Harden's flow sheet. The flotation concentrate was shipped to a smelter. The flotation tailing was cyanided. The mill capacity is 80 tons a day and treatment cost as reported by Harden was $1.445 a ton.

In 1938 the mine produced 22,990 tons of ore which yielded 4,542 ounces of gold, 45,164 ounces of silver, 234,440 pounds of lead and 114,963 pounds of copper. Recently it has been worked on a small scale by lessees.

Spring Hill Gold Mines, Inc. 1915 Mills Tower, San Francisco. Stewart W. Marshall, general manager; C. C. Cushwa, superintendent. Prospecting has been going on at the Spring Hill Mine for a number of years, and a 100-ton plant employing flotation has been operated part time. In general, however, the results to date have not been satisfactory. The shaft has reached a depth of 1,900 ft. and preparations were being made early this year (1941) to handle some ore from that level. Many thousand feet of drifts and other prospecting have been done. About 10 men are employed.

Stockton Hill Mine. The Stockton patented claim contains 20.66 acres in N½, sec. 9, T. 14 N., R. 8 E., on North Fork of Wolf Creek, and mineral rights are also held on adjoining land, giving 1 mile on the strike.

Some work was done in early days, of which no record remains. In 1933, E. C. Boring and brother of Visalia began reopening an old shaft. In February, 1934, a strike of high-grade ore was made at a depth of 150 ft. After passing through various hands it came under the control of F. C. Lowry. In January, 1936, one shaft had been sunk 265 ft. An old shaft is 150 ft. south of this and 110 ft. deep. In the deeper shaft at 150 ft. some very rich ore was found and for a short time 45 pounds of ore crushed daily was said to yield about 50 ounces of gold, the total amount of the "strike" reported to be about $20,000. After Lowry relinquished the lease and option on the mine, Stockton

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[1] D. B. Harden. Min. & Met., Oct. 1935 A. I. M. E. Contribution No. 39.

Hill Mines, Inc. was organized in California in September, 1937, with W. R. Woock, president, Auburn, and Gilford G. Rowland and others of Sacramento as directors. Stockton Hill Corporation was also organized in Nevada. Work has been going on since. The main shaft, formerly 315 ft. deep, reached a depth of 430 ft. in 1939 and a station was cut at the 415-ft. level. This level had been run 235 ft. southeast at time of visit in August, 1939. The vein here is a stringer lead in gabbro-diorite. The face of this level was being carried from 8 ft. to 8½ ft. wide by 7 ft high. On the hanging wall a stringer of quartz 3 inches thick or less occurs, and on the footwall another from 3 inches to 5 inches thick. The two are 68 inches apart, with other quartz stringers between. An ore shoot 150 ft. long was claimed at that time on this level by Walter Woock, who stated the average assay was $10.80. The last few rounds showed a width of from 4 ft. to 5½ ft.

Spring Hill Mine, headframe and mill, Grass Valley. *Photo by H. R. Plate*

On the 265-ft. level ore was claimed for a length of 385 ft. with an average width of 30 inches, and reported assay of $18.95 a ton.

The mine is on the southern part of a peninsula of gabbro-diorite extending south from a batholith nearly 30 miles long. Fringing this peninsula are narrow bands of serpentine and Calaveras (Pennsylvanian) slate. The different veins claimed on this land are partly in or along the contacts of the different rocks but have not been sufficiently opened to be properly correlated.

Some custom ore had been hauled to the Gracie-Glencoe mill at Nevada City. The mine equipment includes two 50-h.p. Diesel engines, air compressor, small hoist and a pump handling 50 g.p.m. which at the present depth is operated 4 hours out of 24.

In January, 1941, it was reported that a Marcy mill of 200 tons capacity, and flotation and cyanidation equipment had been installed and that milling had been started.

Zeibright Mine is on Bear River, 5 miles from Emigrant Gap in sec. 34, T. 17 N., R. 11 E. It is in a region of heavy snowfall.

Nearly a generation ago this mine was worked by Bear Valley Mining Company. The vein was opened by adits, one 990 ft. long giving 400 ft. of backs. The main ore shoot at that time was stoped for a length of 160 ft. and for a depth of 400 ft. on the dip (nearly vertical). The vein was reported 20 ft. wide and was said to yield $2.10 to $3.00 a ton, with sulphide worth only $12 to $14 a ton. A 10-stamp mill was used and the cost of mining and milling was claimed to be only $1.70 a ton, due to the use of cheap power and width of vein.

Empire Star Mines Company has had the mine for 8 years and has mined and milled a large tonnage of low-grade ore. Beginning with 10,285 tons in 1934 and 129,886 tons in 1936, the output in 1939 is said to have been 260,479 tons. Early in 1940 the tailing dam failed and no milling has been done since, pending the working out of a satisfactory plan for tailing storage. Ore development and mill alterations have been carried on.

Recent mining has been carried on through a vertical shaft in which the bottom level (April, 1940) is 1750 ft. deep. Stoping has been carried to a depth of 800 ft. The ore occurs in an impregnated dike carrying bands of quartz on either wall and there is said to be no pay outside the dike. Six to 8 air drills are operated along the face of a 200-ft. stope. A round consists of 10 holes 9 ft. to 10 ft. deep; 65 ft. of drilling a shift is expected. The walls are Blue Canyon slate. A width of about 10 ft. is broken. About 200 men were employed in 1939, some on outside construction.

The following notes on the milling plant, as it will be when full operation is resumed, have been kindly furnished by Mr. F. W. McQuiston, Jr.; metallurgist for Empire Star Mines Company:

Ore, after passing through a 36-inch jaw crusher and Symonds standard crusher, will be crushed in 2 Hardinge mills and 1 Marcy mill and will pass to a Door classifier and Pan-American jigs to save free gold. Overflow will go to Pan-American flotation cells and concentrate from these will be recleaned in Kraut flotation cells. Flotation and jig concentrates will be ground in a pebble mill in closed circuit with a Dorr Bowl classifier and Dorr tray thickener, and will probably be pre-aerated and given a lime wash before cyanidation. The mill capacity will be from 1000 tons to 1100 tons a day and the cyanide plant will handle 30 tons daily. The ore contains free gold, pyrite, chalcopyrite and pyrrhotite.

GOLD PLACER MINING

The gold placer resources of the county are also impressive. Nowhere else are to be found such immense deposits of Tertiary auriferous gravel as those on the San Juan Ridge and southward to Gold Run in Placer County, including the Sailor Flat, Blue Tent, Scott's Flat, Quaker Hill and Red Dog-You Bet deposits. Drilling * has been going on recently with several rigs in the North San Juan-North Columbia region, and the construction of the long-awaited debris dam at the Narrows on Middle Yuba River near the Nevada-Yuba County line has been completed. It furnishes storage for hydraulic tailing from all mines draining into the Middle and South Forks of Yuba River, excepting those near Smartsville. If the necessary water supplies are available, it will now be possible to rejuvenate hydraulic mining on a scale never equaled since the closing of the North Bloomfield mine.

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* Suspended after the war started in Europe.

The State Mining Bureau and its successor, the present State Division of Mines has actively participated in the efforts to further the resumption of hydraulic mining, publishing three reports on the subject. The first of these, titled ''Gold Placers of California'' (Bulletin 92 of the State Mining Bureau) was published in 1923. It summarized the information concerning the gold placer resources of the state and emphasized the desirability of providing means for disposal of hydraulic mining debris, with some general suggestions for doing this. Again, in 1925-1927, the State Mineralogist was a member of the Hydraulic Mining Commission, created by the state legislature of 1925 to investigate the ''feasibility of any plan or plans whereby hydraulic mining can be resumed in California.'' The report of Arthur Jarman, engineer employed by the commission, was a careful, detailed appraisal of the more important gravel deposits amenable to hydraulic mining in the basins of the Yuba, American and Bear Rivers, and estimates of the production of gold that might be expected if means could be provided for storing mine tailings at reasonable cost. This report was printed as the January chapter of Report XXIII of the State Mineralogist (1927) and is still available.

The fight for provision of storage facilities was carried to Congress in 1933 and the Board of Engineers for Rivers and Harbors were directed to review the subject of debris control and the matter of federal participation in providing dams for this purpose. The work was delegated to the California Debris Commission, the local federal agency having jurisdiction over activities of this kind which affect the navigability of Sacramento and San Joaquin Rivers. Their report, made in February, 1935 recommended against federal participation in building the dams. This led to a protest from California mining interests, in which the State Mineralogist participated. As a result of the hearing, at which an exhaustive and convincing brief was presented by Walter W. Bradley, State Mineralogist, to the Board of Engineers at Washington, the board reversed the decision of the California Debris Commission, and recommended the construction of 4 debris dams. An amendment calling for an item of $6,945,000 to defray their cost was added to the Rivers and Harbors bill in 1935. Bradley's brief was a review of the entire matter and a compilation of data dealing particularly with the yardages and gold content of gravel already mined by hydraulicking, presented as sampling results of what might be expected by working remaining deposits. It was published in the July chapter of Report XXXI of the State Mineralogist (1935) and is still available at our offices. The above reports have given so many details concerning the hydraulic mining resources that these need not be covered here.

Nev Co – Placer gold

Among the debris dams mentioned above, the Narrows dam is the most important to Nevada County. This was completed late last year, and water began spilling over the dam on Christmas night, 1940. These dams are designed to hold mine tailing and debris from natural erosion over a 20-year period, during which time the charges for mine tailing storage are to be set at a figure that will return the cost of each dam, without interest charges. Electric power development, utilizing fall of water from the dams, and already planned for Narrows Dam, will help to reduce storage cost.

Up to the time of closing this report (Mar. 31, 1941) two hydraulic mines have been put in operation behind Narrows dam.

The situation regarding hydraulic mining on the Bear River watershed is not as favorable to the miner as on the Yuba River. Under conditions existing in recent years, hydraulicking has been stopped because of alleged roiling of a domestic water supply served to several towns in Placer County, and conflict with other rights of a public utility. It also appears that water rights formerly belonging to the hydraulic mines have passed into other hands to such an extent that new arrangements for water supplies from such agencies as Nevada Irrigation District and Pacific Gas & Electric Company would have to be made before hydraulic mining could be resumed on a large scale.

Both these agencies indicated at a meeting in Auburn in October, 1939 that they then had no water available for mining on Bear River watershed. So far, because of the uncertainties concerning assurances to mine, the federal government has not begun dam construction.

Omega Hydraulic Mine is (Mar. 1941) operating 3 monitors 3 shifts. This is a famous old mine near Washington where 13,500,000 cu. yds. of gravel was hydraulicked in years past, giving an average reported yield of 13½¢ a cu. yd. Fifty-five years ago, according to J. S. Kramer who worked there as a miner, this mine paid $8000 per claim (100 ft. by 100 ft.). This mine has the second right to water from South Yuba River and claims 5000 miners inches, which is in conflict in summer with a power company. From 24,000,000 cu. yd. to 26,000,000 cu. yd. of gravel remain. Some work has been done in late years. See our 1930 and 1927 reports. Jack Little, general manager; Theodore Larsen, superintendent.

Western Gold Incorporated. W. H. Taylor, 943 Russ Bldg., San Francisco. C. E. Clark, superintendent. This company claims the honor of being the first to begin hydraulic mining behind the new Narrows dam. One giant has lately been in operation continuously and another will be started soon. A crew of 20 men are employed. The *Relief Hill mine,* where this work is going on, is 3 miles east of North Bloomfield and is one of the old mines closed by injunctions. Some 6,000,000 cu. yd. of gravel was hydraulicked there previous to that, and in later years there was some production from drift mining. Jarman [1] estimated from 5,000,000 cu. yd. to 15,000,000 cu. yd. remaining available, though owners estimate 30,000,000 cu. yd. is available southwest and west of the old workings. The mine has a normal season of four months in average years and in the past has had about 1200 inches of water but may be able to purchase more.

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[1] Report of the Hydraulic Mining Commission to the Legislature of 1927. (In Report XXIII of State Mineralogist.)

In dry weather, and in the past over a long period of years, drift mining has been carried on, and the present operator has continued this practice, calling the drift mine the *Lucky Jane.* Details of past work are given in our former reports, especially in the 1930 report.

Buck & Stock Placer. Alexander Buck, Lincoln, and Lee Stock, Grass Valley, have recently leased Birdseye Canyon Placer Mine comprising lot 65 in sec. 31, T. 16 N., R. 10 E., and lot 52 in sec. 6, T. 15 N., R. 10 E., containing 49 acres. This is an old tailing claim, the canyon being filled with sand and gravel from hydraulic mines worked in years past.

A $\frac{3}{4}$ cu. yd. gasoline shovel will be used for digging, and a ''dry land'' washing plant with a trommel and sluices mounted on a track for recovering gold. Work has not yet started (April 1, 1941).

El Oro Mining Company, San Francisco, has been working on the Planet, Steep Hollow and Mule Spring Ranch placer claims in Lowell Hill district since 1935. A bedrock tunnel is reported to be 2730 ft. (Dec. 1940) and the operators claim a large yardage of gravel has been opened, which they say carries $2.50 or more in gold per cubic yard. Eight men have been employed recently under Dan M. Donnelly, superintendent.

General Dredging Company, Sacramento, operated a dragline in Celestial Valley in 1940 on small parcels of land belonging to several owners. In all about 30 acres is said to have been worked. The work ended Dec. 10, 1940 and the dragline was moved to Folsom.

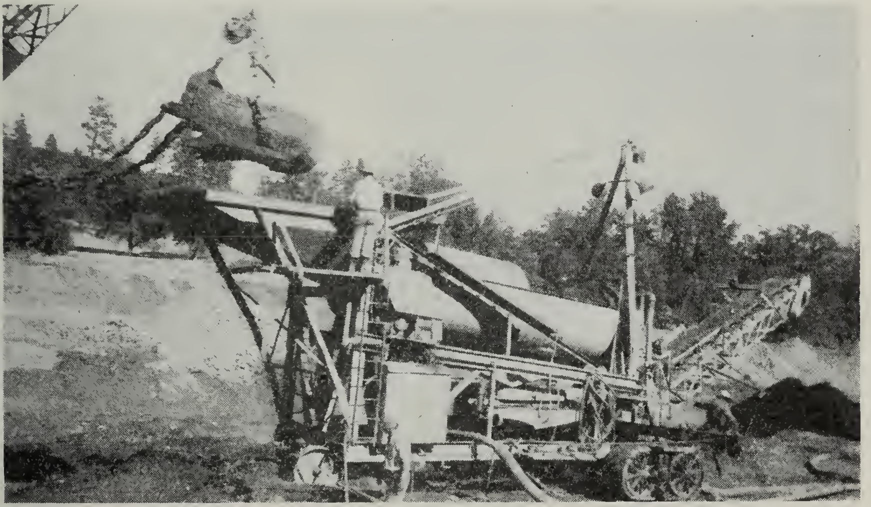
Innis Dredging Company (not incorporated). A. B. Innis and associates, who had previously operated a dragline dredge outfit in Butte County, moved it to Deer Creek below Nevada City, Nevada County in the spring of 1938. In a period of 21 months between May 1938 and Feb. 1940, they dredged a total of 1,500,000 cu. yds. of gravel. The returns were satisfactory. A P. & H. dragline, model 955 L with $2\frac{1}{2}$ cu. yd. bucket and 60 ft. boom, operated with a Fairbanks Morse diesel engine was used for digging. The washing plant was mounted on a 30-ft. by 45-ft. barge, with a 54-in. by 25-ft. trommel.

Considerable coated gold was found, and a special method was used in recovering this. The fine material was taken from the riffles to shore, where it was washed in tubs of 6 cu. ft. capacity filled $\frac{2}{3}$ full of water heated to 150° F., to which a pint of granular NaCN was added.

Kaufield & McKinley Dragline. J. Kaufield and H. W. McKinley. When visited Aug. 21, 1940 this plant was being operated on the F. S. Parker ranch on Wolf Creek 0.7 mile from the Auburn-Grass Valley highway. Previously it had been used near Loomis and Redding.

Digging is done with a model-6 Northwest dragline using butane fuel and having a $1\frac{3}{4}$ cu. yd. Essco heavy-duty bucket and 55-ft. boom. Gravel is washed in a ''dry land'' plant on caterpillar treads. This has a trommel 54 inches by 20 ft., a 50-ft. tailing conveyor and 4 Ainlay bowls. The bowls handle 8 cu. yd. an hour each of the fine material passing through the trommel, which receives a total of about 75 cu. yd. an hour. The bowls run 89 r.p.m. and require 500 g.p.m. of water. The washing plant is operated by a 65-h.p. Caterpillar diesel generator which also supplies lights and 25 h.p. for pumping water.

An area of about 20 acres had been mostly worked off at time of visit. A special feature of the work was required by the land owner's desire to have the land left in condition for cultivation after dredging. The overburden of soil was removed and piled to one side. After washing the gravel for gold, it is leveled and the soil is replaced. A Caterpillar diesel tractor is used. The cost depends on the relative proportions of gravel and soil, which in this case is about 1 to 1. Archie Dennison is superintendent and 12 men are employed.



"Dry land" washing plant used with Kaufield & McKinley dragline dredger on Wolf Creek, August, 1940. This land was resoiled after dredging

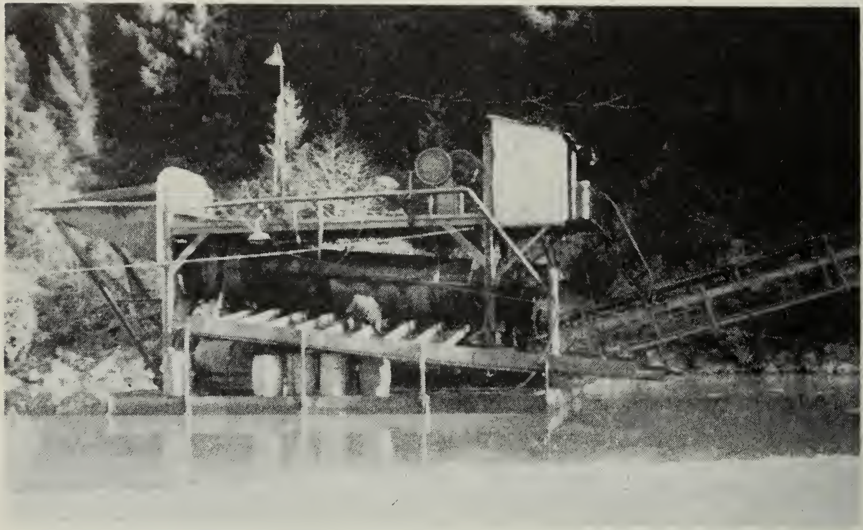
Wm. Richter & Sons put a dragline outfit in operation early in December, 1940 on a gravel deposit below Freemans Crossing on Yuba River. It has been working 3 shifts and has been handling 2000 cubic yards a day. A crew of 10 men is employed.

San Carlos Gold Dredging Company. L. A. Morrison, Gus Manuel and Ed Sandberg. This group is operating a No. 5 Northwest dragline and floating washing plant on Steep Hollow Creek near the bridge on the You Bet-Little York road, probably in the north ½ of sec. 5, T. 15 N., R. 10 E. The gravel being worked consists of old tailings from hydraulic mines once worked at Lowell Hill and vicinity. It averages about 12 feet in depth and is loose and easy to dig. Work started Apr. 6, 1940.

The dragline is on caterpillar treads, is operated by a diesel engine and has a boom 55 ft. long, permitting work to a depth of 20 ft. It handles about 2500 cu. yd. in the usual 20- to 22-hour run.

The washing plant is on a barge 32 ft. by 24 ft. drawing 3 ft. to 4 ft. of water. The trommel is 32 ft. long, sets on a grade of 1½ inches to 1 ft. and has 8 ft. of ⅜ inch and 8 ft. of ½ inch holes. There is a total of 384 sq. ft. of Hungarian riffles, which are underlain by expanded metal and cocoa matting. The first set of riffles has a grade of 1½ in. per ft. and second set a grade of 1¾ in. per ft. and quicksilver traps are provided. Coarse tailing is stacked by a belt conveyor 35 ft. long.

Power for operating the washing plant and pumping water is supplied by a General Motors 90-h.p. 480-volt diesel electric generator. About a mile and a half in length has been worked and ½ mile remains. Ten men are employed with F. R. Juchtzer as superintendent. A Lincoln arc welder is used for repair work and building up bucket teeth, and an Allis Chalmers tractor for general use.



Washing Plant, San Carlos Dredging Company, on Steephollow Creek, October, 1940

Shovel Placers. This dragline project, designed to work old placer mine tailings and some new gravel near Columbia Hill was worked intermittently and with mixed success for several years.

Lately it has been taken over by H. W. McKinley and J. Kaufield. McKinley is said to have since severed his connection with the property. A crew of 18 men is employed. It is a dry land outfit. (See Kaufield and McKinley, ante.)

GOLD

The future of gold mining and the much debated question of the importance of gold are subjects of great interest to the people of California as a whole. Will the present war result, as did the first World War, in a general increase in prices of all other commodities and services in relation to gold so that gold miners are put at a disadvantage? Since 800 B. C. gold has been used in coins as a medium of exchange because of its physical properties, resistance to corrosion and comparative scarcity. No other medium has been found as suitable or as acceptable by as great numbers of people.

The following article by Arthur B. Foote, formerly general manager of the North Star Mines Co. at Grass Valley has been previously published in the Proceedings of the Mining and Metallurgical Society of America and was also printed in The Mining Journal, London, for April 1, 1939. It will do much to clear up confusion about the price of gold, the necessity for its use in international trade and its importance as a basis for our currency.

THE PRICE OF GOLD *

By ARTHUR B. FOOTE, Mining and Civil Engineer,
Box 1026, Grass Valley, California

A year ago the "Gold Symposium" was published by the Society and the authoritative article by Percy E. Barbour with the discussion was of great interest.** A decided difference of opinion regarding several phases of the subject developed, so that it was left to the reader to decide which of two opposite views was correct. In the year that has passed articles have appeared in other publications criticising the policy of buying gold at a high price with borrowed money merely to bury it in a vault. It has been stated that foreign nations are dumping their gold in the United States with the intention of abandoning the use of it in their monetary systems, with the inevitable result that we shall have all the gold in the world and it will be of no use whatever. Colonel Barbour reached the conclusion that the price of gold must inevitably decline, and at a later meeting of the Society, Dr. Moulton expressed the belief that it would neither decline nor advance. After all, gold has been used as money all over the world for hundreds of years, and its value for that purpose should be something more than a matter of opinion. But during and after the World War the monetary systems of all the nations engaged were subjected to severe strain and some broke down, and I believe that a study of gold in connection with these financial vicissitudes will lead to some definite conclusions and a better understanding of the true function of gold.

PRICE FLUCTUATIONS AFTER A MAJOR WAR

It is a matter of history that prices rise during a major war; that there is a sudden drop lasting for perhaps a year immediately after peace is declared; that this is followed by another period of high prices lasting about 10 years and then comes a four-year depression, during which prices return to normal or below. I remember looking this matter up back in 1920 in order to find out how soon we could again expect to operate a gold mine at a profit, and the curve of prices which gave the information went back to the Napoleonic wars. In California only a few of the larger mines continued in operation throughout the period of high prices, the production of gold dropped from $22,400,000 to about $8,500,000, including production of dredges and placers. In 1918 I believe the *Homestake* was the only one of the larger gold mines in the United States that made a legitimate profit. The increase in costs was about 60%. Then came the depression, prices began to drop and production to increase, but the wage scale of the large mines went down only 10% or 15%. A lot of the added production was due to people going in for gold mining because they could not make money at anything else, and gold was almost the only thing for which there was a market.

CHANGE IN PRICE OF GOLD DOES NOT ALTER ITS VALUE

When the price of gold was raised to $35.00 an ounce, wages were immediately increased and prices went up also, with the result that the gold mines are little better off than they were before the war. In 1913 a miner's wage was $3.00 a day, therefore, he worked a little less than seven days for an ounce of gold. Now wages in Grass Valley are $5.72, but many miners in California are getting $5.00 a day, the same wage as in 1913 measured in gold. A miner can buy no more in the way of living expenses with $5.00 now than he could with $3.00 then. The production of gold in California was almost exactly the same number of ounces in 1937 as it was in 1915, and in lode mining, the same number of ounces of gold per ton of ore determines the dividing line between profit and loss now as it did then. During a trip to Europe this summer I observed that the price of meals and many other things in terms of gold was about the same over there as it was in San Francisco in 1913. The above is offered as evidence that changing the price of gold in currencies does not alter its value or that of other commodities. More will be said about this later.

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* Proceedings of the Mining and Metallurgical Society of America.

** See M. J., December 11, 1937, p. 1117.

GOLD THE COMMON UNIT OF FOREIGN TRADE

Foreign trade consists of an exchange of goods between different nations; there must be some common unit by which the value of the goods is measured in the currency of each nation, and a specified weight of gold has been used for that purpose for generations. To convert francs into dollars, the value of an ounce or gram of gold in terms of both currencies must be known. When one country sells more than it buys the balance must be settled in gold, and the only way a nation can acquire gold, except from its own mines, is in exchange for goods or securities. It was reported that the balance of trade in favor of the United States last year amounted to $700,000,000, and it follows that 20,000,000 ozs. of gold were consigned to those that sold the goods. But only the United States government is allowed to possess gold, so it is forced to buy all that is offered and credit the consignees with its value at $35.00 an ounce. The producers of the goods receive their payment in United States currency which is obviously based on gold. The gold is put in the vault, and if it is never seen again the people of the United States are richer by $700,000,000, and the gold is the measure of that wealth. It is transactions of this kind that create a demand for gold. Now suppose the sellers of these same goods had demanded 34,800,000 ozs. in payment, as they would have done when the price was $20.67 an ounce; the goods would probably not have been sold because other countries were offering them for less. Is not that the answer to the criticism of Uncle Sam for ''running a one man corner on gold,'' or buying all the gold that is offered at more than the market price? In France the pre-war price was about 100 francs per oz. and now it is about 1000, but France has a difficult financial situation because she has not enough gold. She cannot get more because she has not the surplus goods to offer in exchange.

When gold is shipped to this country for safe keeping, the law against private ownership compels the United States to buy it and give the owner credit, the same as when it is sent in payment of goods. The credit can be used only for purchases in this country or return of the gold, and neither should cause embarrassment as long as it remains intact. Presumably it is gold received in this way that is ''sterilized.''

NATIONAL SOLVENCY BASED ON GOLD

An individual can borrow money by putting a mortgage on his house, but a nation must offer for security a commodity of permanent value that can be transported, and gold is used all over the world as a basis of national and international credit. Of all the nations engaged in the World War, Great Britain and the United States were the only two that were not practically insolvent at the end, because only they had been able to maintain an adequate reserve of gold; the former because she had received the production from her mines in South Africa by paying a premium, and the latter because she had a favorable balance of trade for the three years before entering the war. It is interesting to note that the enormous loss of wealth caused by the war was accompanied by a corresponding loss of gold, the measure of wealth, either by paying out gold for goods to replace the loss, or by borrowing money with an inadequate gold reserve. In Germany there was a complete loss of all the people's savings in bonds and currency; in France, the loss of income from investments caused by a greatly depreciated currency. Great Britain and the United States lost the money loaned to other countries and a lesser amount from depreciated currency. This all results in less world buying power, so we can not expect to be as prosperous now as we thought we were in 1926. We found out later that the large production which caused that prosperity could not be paid for in gold.

UNITED STATES HAS BORROWED $3 FOR EVERY DOLLAR HELD IN GOLD

The United States has borrowed about $3.00 for every dollar's worth of gold in the treasury. How much more she can borrow is a question to which the experience of other nations does not seem to afford an answer. But experience does indicate that if too much is borrowed the debts will be worth no more than the value of the gold in the treasury. As long as expenses exceed receipts gold must be bought with borrowed money, but if the Government refused to buy any gold that was offered, it could not borrow for two reasons; foreign trade would be checked and the gold reserve would diminish. The Government has got itself into a situation that would be ludicrous if it were not tragic. It has deliberately destroyed wealth in order to make the people richer. To reduce unemployment a law was passed making it impossible to employ anyone who does not produce a specified amount of wealth in a given time. Other laws were passed designed to decrease the production of goods and services per inhabitant, and the people are told that this will result in a higher standard of living. Because this is contrary to fact, the Government is forced to borrow wealth that was produced in the past to make up for the lack of production and keep the people from starving. In spite of the favorable balance of trade, which should have resulted in a surplus of $700,000,000, there was a deficit of three or four billions.

As a result of the depression, by 1932 prices in other countries had dropped lower than they had been allowed to do in the United States, which resulted in an unfavorable balance of trade and an outflow of gold. Fear of what the president-elect might be going to do with the currency caused this outflow to become a flood of gold being sent abroad for safe keeping, and was checked by the embargo on its export and the moratorium. When it came time to lift the embargo and resume foreign trade, in order to prevent a continued loss of gold it became necessary to lower the price of our goods in terms of gold, and this was done by depreciating the currency. When the price of gold was first raised other countries started to do the same thing, in order not to lose their advantage in trade, but it was finally fixed at $35.00 an ounce with the British pound at its pre-war price of $4.86.

TRUE INDEX OF PROSPERITY IS VOLUME

In many other countries the currency depreciated in spite of anything that could be done because of a scarcity of gold and lack of credit, but it is bad business and results in a great loss of purchasing power for all incomes derived from interest on bonds, etc. Had prices and wages been allowed to sink to the 1913 level, there would have been no necessity in the United States for depreciation, but, instead, employers were urged not to lower wages ''in order to maintain purchasing power.'' But high wages do not increase the purchasing power of the wage earner, because the part of the wage increase that may be paid out of profit is simply transferred and the balance must be added to the price, which decreases the purchasing power of those that are not wage earners. The true index of prosperity is the volume of goods and services produced; that is the national income and constitutes all that there is to be divided among the people; if the value of this in currency is increased 69%, it is of no greater value to the people for food and clothes, and a large number of people have no more dollars to buy with than they had before, so they can not buy as much; the demand is less, and people are thrown out of work. While depreciating the currency increased the purchasing power of the foreign market, that of a large part of the domestic market was lowered. Dr. Anderson defined the functional price of copper as the price at which it will move. At present[1] we have a number of Government officials devoting their time to the business of lifting commodity prices above that level. Wage earners are being paid more than they earn at the market price of what they produce. Because the railroad workers are paid more than their service is worth, the fruit growers in California can not sell their fruit in New York at the functional price. To spend money and limit production appears to be the motto of our Government at present.

When our nation sells more than it buys there is a demand for gold to pay for the balance. The United States has been acquiring in this way the total world production of gold for several years. Probably one reason for this large volume of trade is that there are two wars going on and a great deal of rearmament on the part of other countries. The reason this country has half of the world's supply of gold is that it has about half the wealth.

The true value of an ounce of gold, which is determined by supply and demand, can not be measured in the fluctuating currencies of different nations, but must be determined by the quantity of goods and services for which it can be exchanged. The relative value of gold and goods depends upon the hours of human labor required to produce each, and this in turn depends upon the efficiency of labor and the tools provided by capital.

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[1] Written in 1939.

Gold being a commodity, the value of a unit of weight is not a fixed quantity; however, its value appears to be less subject to fluctuations than that of other commodities, probably because it is of little use except for monetary purposes. Miners in California have been working for nearly the same wages in terms of gold for forty years, except during periods when prices were unquestionably above normal. The value in gold of the national income of the United States was 34.4 billion dollars in 1913, rose to 83 billion in 1929, dropped to 39.4 in 1932, and was 42 billion in 1937. This latter figure is computed from a newspaper report of 70 billion in currency, and is almost certainly income paid out. Using the 1932 figure for excess withdrawn would bring this to 32 billion dollars as the value of income produced in 1937. Considering these figures in connection with prices and the number employed at the different periods indicates that there has been no great change in the gold standard of value. It shows that 130 million people in 1937 were producing less than 97 million were in 1913, and it shows what an altogether false idea of national prosperity was given by the report of a 70 billion dollar income in 1937. If that had been the true value of the production of goods and services, there would have been no unemployment nor necessity for relief.

At the present time France, Germany, Italy, Japan and China are in great need of gold, but the volume of their demand for gold is limited to the quantity of goods, in excess of their domestic requirements which they can offer in exchange. The world demand for gold evidently depends upon its capacity to produce wealth, and will continue as long as any nation sells more than it buys. It seems possible that the demand for gold would cease if and when there were no more wars, if all nations paid off their debts and if the value of all exports and imports in the world were balanced.

MANGANESE

Some manganese oxide ore was mined and shipped from deposits in Nevada County during the world war years of 1915-1918.

Bartholf & Veach Mine is 7 miles from Colfax near the west bank of Bear River. Manganese oxides occurred in quartz lenses similar to the deposits in Placer County. Three carloads of ore were mined and shipped in 1915 and 1918.

Duggan Manganese Prospect, Daniel F. and Orea A. Duggan, owners. Chas. W. Leiter, Nevada City, lessee in May, 1939, but no work was going on at time of visits in August, 1939, and August, 1940. In W$\frac{1}{2}$ of SE$\frac{1}{4}$, sec. 17, T. 14 N., R. 8 E., near Wolf P. O. beside the road to Limekiln Ranch.

Three shallow holes have been sunk in a distance of 60 ft. on a line striking N. 73° W. From these $\frac{1}{2}$ carload or less of manganese oxide ore has been mined and piled nearby. There is no further showing of manganese in the immediate vicinity. The north wall of deposit is a heavy fine-grained green to black igneous rock. The south wall is not exposed, but on the slope above and to the east the Calaveras quartzite (Pennsylvanian) outcrops. From what could be seen, the ore was 2 ft. to 3 ft. wide.

Good Enough No. 1 and No. 2 claims are probably in N$\frac{1}{2}$, sec. 9, T. 16 N., R. 8 E., on the south side of Rush Creek 3$\frac{1}{2}$ miles northwest of Nevada City. Wm. Rose, Pioneer Hotel, Nevada City, owner. Rose reports he has uncovered a vein of manganese ore 4 ft. wide and extending 35 ft. on the strike. Some other small outcrops have not yet been stripped of overburden, and no sinking has been done on the ore exposed. Rose claims assays have indicated from ''65% to 73% manganese'' (the maximum Mn content possible for the definitely determined Mn compounds is 72% plus for hausmannite, 63.6% for braunite). Rose described the hanging wall as ''granite'' and footwall as ''birdseye porphyry.''

Wren Ranch is in sec. 20, T. 14 N., R. 8 E., in Wolf district. In 1917, a few tons of manganese oxide ore said to carry over 50% manganese and 6% silica, was mined.

MINERAL PAINT

Taylor (Iron Mountain) Mine is in sec. 4, T. 15 N., R. 7 E., a mile northwest of Indian Springs. Norman L. Wimmler and Orrin P. Peterson have a license to mine from the owner, U. S. Smelting, Refining & Mining Co.

Mining iron ore for paint, near Indian Springs, Nevada County
Peterson and Wimmler, operators

The property has previously been described as a copper prospect and considerable work was done upon it, which disclosed a body of pyrite with some copper. The present work however (August, 1940) has been for the production of iron oxide from the gossan capping, for use in paint. Bodies of high-grade oxide are selected at different spots on the 100 acres.

When visited, 3 men were mining 10 tons of ore daily by hand from the gossan outcrops. A portable compressor furnishes air for drilling 6-ft. holes which are blasted with dynamite. Large pieces are broken by hand and further blasting and the ore is hauled by trucks directly to the Emeryville plant of C. K. Williams Company. It is calcined and used for making ''box car red'' paint. After being calcined, the product is mainly Fe_2O_3. A sample from 20 ft. of channeling showed 3.6% silica, 0.19% sulphur and 11.61% ignition loss. There is a small amount of gold present, not sufficient to justify work, according to Peterson's sampling. The working season is about 3 months.

SAND AND GRAVEL

Grass Valley Rock & Sand Company. D. V. Brown, manager. Sand and gravel are dug from Greenhorn Creek 7½ miles from Grass Valley on leased land. A "high line" with a ½ cu. yd. bucket and double drum hoist is used for digging. From 1 to 4 men are employed. Most of the output is sold in Grass Valley.

TUNGSTEN

Scheelite has been noted at a number of mines in the Grass Valley district, but only one deposit has been commercially developed. During the previous world war, one of the quartz veins being worked in the *Union Hill Mine* was found to contain scheelite. It was worked from 1916 to June, 1919 when the mine was closed. The Tungsten vein, as it was called, was found in a crosscut driven 500 ft. south from the 600-ft. level of the Union Hill shaft. The vein was 6 ft. wide and the ore was found in seams from ½ inch to 16 inches wide. This vein strikes N. 55° W. and dips 70° SE. On the 800-ft. level it unites with another vein which strikes N. 45° W. and dips 65° SE. In both, the scheelite followed the footwall. Part of the stamps and Deister concentrators in the gold mill on the property were utilized to crush and concentrate the scheelite ore. Part of the concentrate which contained pyrite was roasted to release the gold and permit its separation from the scheelite.

Bibl: Mines and Mineral Resources of Nevada County, 1919; p. 263.

Scheelite has been noted at various depths in the gold vein of the *Empire Mine* and especially on the 3000-ft. level. The amounts are too small to warrant recovery.

In the mill at the *Lava Cap Mine* (1940) a line of heavy concentrate, stated by Delbert Schiffner to be scheelite, was noted on a concentrating table which receives tailings from a jig. No effort was being made to save this because of the small amount and the difficulty of separating it from the sulphide.

Pioneer Mine (Mitchell Ranch Mine). On the 170-ft. level of this mine, 2 miles east of Grass Valley, the quartz vein was found to contain irregular bunches of reddish-brown scheelite. This vein is from a seam to 2 ft. in width and carries some pyrite, chalcopyrite and galena, in addition to the scheelite and variable assays for gold. Only a limited amount of work was done at this property and no special attention was paid to the scheelite.

Bibl: R. XXVI, 1930, p. 127.

Scheelite occurs in samples of quartz ore taken by Fred M. Miller, mining engineer, Grass Valley, from one of the dumps at the Amador Consolidated Mine, east of the Norambagua Mine and near the south end of the district. No production of scheelite has ever been made from the property.

The wide distribution of scheelite indicated by the above short notes suggest that it may be much commoner than realized in the gold quartz ores of the Grass Valley region.

TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Accidental	5, 6	15 N.	8 E.	----------	----------	See Alcalde Mines
Ajax	2, 11	15 N.	8 E.	Ajax Gold Mng. Co., Mrs. Josie Spargo, Agt., Grass Valley	20	Reg. Mines; M. M. R. Nev. Co., p. 109
Alaska	1	15 N.	8 E.	Grass Valley Bullion Mines, Inc., 1101 Alaska Commercial Bldg., San Francisco, c/o Edgar T. Zook	8	Reg. Mines; M. M. R. Nev. Co., p. 109
Alcalde Mines	5, 6	15 N.	8 E.	Mattie Gold Mining Co. (lapsed 1933)	200	M. M. R. Nev. Co., p. 111-112; Pre. Rp. 8, p. 30; XVII, p. 435; XVIII, p. 139; XXI, p. 9; XXVI, p. 101; XXXI, p. 16
Allison Ranch Mine	2	15 N.	8 E.	Grass Valley Cons. Gold Mng. Co., H. A. Heilbron, Jr., Secy., 209 Capital Natl. Bank Bldg., Sacramento	64	XI, p. 268; XIII, p. 234-235; M. M. R. Nev. Co., p. 112-116; XVII, p. 435; XXVI, p. 101; Reg. Mines; Pre. Rp. 8, p. 30
Allison Ranch Ford	2	15 N.	8 E.	Allison Ranch Ford Gold Quartz Mng. Co., Gertrude Ford, Agt., 442 S. Bedford Dr., Beverly Hills	16	See Allison Ranch
Alls Well	15, 16 21, 22	16 N.	8 E.	Wm. Crase, Le Duc St., Grass Valley, et al.	29	----------
Alpha	25, 26	16 N.	8 E.	Foothill Farms, Inc., Grass Valley	3	M. M. R. Nev. Co., p. 116; see Golden Gate Gp.
Alpine	17	16 N.	9 E.	See St. Louis Mine	18	XIII, p. 235; M. M. R. Nev. Co., p. 116
Alta	----------	----------	----------		----------	See Spanish
Alta & Bingham Cons.	16	17 N.	11 E.	A. E. Murphy, Nevada City, et al.	40	----------
Alta Hill (chrome)	22	16 N.	8 E.	----------	----------	M. M. R. Nev. Co., p. 71
Amador Cons. (Amanda)	11	15 N.	8 E.	Donald W. Johnson, P.O. Box 363, Folsom	34	Reg. Mines
Ancho	16, 17 20, 21	18 N.	11 E.	Mary Mainhart, Ancho-Erie Mng. Co., Agt., Graniteville	80	M. M. R. Nev. Co., p. 116-117; XX, p. 9; XXVI, p. 101; XXXI, p. 11
Annie & Russel Ravine Lodes	15, 16	18 N.	11 E.	----------	28	See Rocky Glen
Any Port in A Storm	9	16 N.	9 E.	Mrs. C. E. Frazier, Trinity, et al.	11	Reg. Mines
Arctic	2 35	17 N. 18 N.	11 E. 11 E.	Martin Vanberg, Nevada City, et al.	----------	Reg. Mines; M. M. R. Nev. Co., p. 117-118; XIII, p. 235; XX, p. 9
Arkansas Traveler (copper)	13	15 N.	6 E.	H. C. Lewis, North Bloomfield	80	M. M. R. Nev. Co., p. 81-82
Atlantic	----------	18 N.	11 E.	----------	----------	XIII, p. 235; M. M. R. Nev. Co., p. 118
Auroral Star	14	16 N.	8 E.	----------	----------	Reg. Mines
Baby Con.	26	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	8	----------
Badger	26	16 N.	8 E.	See Empire Mine	6	----------
Bagley	----------	----------	----------	----------	----------	M. M. R. Nev. Co., p. 118-119
Baker Prospect (chrome)	26	16 N.	8 E.	D. Whilden, Grass Valley	----------	M. M. R. Nev. Co., p. 71
Baldwin	26	16 N.	6 E.	S. Leila Hoover, Exec., 3131 60th Ave., Oakland, et al.	----------	----------
Baltic	26, 27 34, 35	18 N.	11 E.	In estate; address Bertha A Correia, Aptos, Calif.	52	VIII, p. 451; XII, p. 185; XIII, p. 235; M. M. R. Nev. Co., p. 119

Banner Cons.				See Norambagua & Lava Cap		XVIII, p. 7; XX, p. 9; XXVI, p. 101-102; XXXI, p. 17
Banner Mt. (clay)	30	16 N.	9 E.			Bull. 99, p. 136, 315
Barron						See Washington (German Cons.)
Bartholf (manganese)				E. H. & W. E. Bartholf, et al.		M. M. R. Nev. Co., p. 262; Bull. 76, p. 51
Bavaria	11	16 N.	8 E.	Carl P. Jones, Grass Valley	5	See Champion Gp.
Bayard Taylor	12	16 N.	8 E.	Carl P. Jones, Grass Valley	13	See Champion Gp.
Beaser Ranch (clay)	15	15 N.	9 E.			Bull. 99, p. 136, 313
Becker						See Washington (German Cons.)
Beckman	17, 20	16 N.	9 E.			VIII, p. 453; XI, p. 295; XII, p. 192; XIII, p. 235 (see Mayflower)
Belcher	9, 10	17 N.	13 E.	Theodore D. Robinson, 7 Fairwood Rd., Madison, N. J., et al.	21	
Bella	9	17 N.	13 E.	See Sylvanite	14	
Belle of France	3	15 N.	8 E.	Emile Pettijean, Grass Valley	19	
Belle Fontaine	9	16 N.	9 E.	Belle Fontaine Mng. Co., c/o Mebius & Drescher Co., Sacramento	8	Reg. Mines; XII, p. 185-186; XIII, p. 235; M. M. R. Nev. Co., p. 119
Belle Union	11	15 N.	8 E.	In litigation June, 1940	80	M. M. R. Nev. Co., p. 120
Belle Francis						See Coan
Ben Franklin Con.	1	15 N.	8 E.	Ben Franklin Con. Mng. Co., M. S. White, Agt., Grass Valley	30	Reg. Mines; X, p. 383; M. M. R. Nev. Co., p. 120; XX, p. 9; XXVI, p. 102
Berkeley Prospect (copper)	6, 7	16 N.	8 E.		480	M. M. R. Nev. Co., p. 82
Berlin Cons.	5	16 N.	9 E.			Reg. Mines
Berriman Cons.	27	16 N.	8 E.	See Golden Center		Reg. Mines; XIII, p. 235-236 (see Golden Center Gp.)
Betsy	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	5	See Sultana
Big Bend (copper)	25, 36	17 N.	7 E.		60	Bull. 50, p. 199; M. M. R. Nev. Co., p. 82
Big Blue						See Murchie
Big Four	8	17 N.	9 E.			Reg. Mines
Biggs & Sims	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	27	See Sultana
Birchville	15	18 N.	11 E.	See Iowa Cons.		M. M. R. Nev. Co., p. 121-122
Bitner Gp. (copper)	13	15 N.	6 E.			Bull. 50, p. 199; M. M. R. Nev. Co., p. 82-83
Black Bear (Forlorn Hope)	13, 14 23, 24	16 N.	7 E.	Cooley Butler, 744 Title Ins. Bldg., Los Angeles	400	Reg. Mines; M. M. R. Nev. Co., p. 122-123; XXVI, p. 102; XXXI, p. 11
Black Hawk	25, 26	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley		M. M. R. Nev. Co., p. 123
Black Prince	13, 12	16 N.	8 E.	Claude Stark, Grant Bldg., Rm. 70, San Jose		See Mountaineer
Blake Mng. Ground (Selby Hill)	1 6	16 N. 16 N.	8 E. 9 E.	C. A. Graham, Nevada City	50	
Blue Bell Gp.	11, 12	17 N.	11 E.	See Washington	17	VIII, p. 437-440; M. M. R. Nev. Co., p. 123; see Washington (German Cons.)
Blue Bell	34	16 N.	8 E.	Empire Star Mines Co., Ltd., No. Star Mine, Grass Valley		
Blue Bird Cons.	1	15 N.	8 E.	Andrew McCabe, Grass Valley, et al.	33	
Blue Cloud Cons.	15, 16	18 N.	11 E.	Wm. Simkins, Box 885, Nevada City (trustee)	47	
Blue Fox						XXXII, p. 189-204
Blue Jay Gp.	27, 28	17 N.	11 E.	Zeibright Gold Mng. Co., Nevada City	40	

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* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Blue Jay	2	17 N.	11 E.	T. A. Kohler, Grass Valley	11	Reg. Mines; VIII, p. 452; XIII, p. 236; M. M. R. Nev. Co., p. 124
Blue Ledge	4, 5	16 N.	9 E.	Grace Jones, Nevada City, et al.	19	----
Blue Rock	36	17 N.	8 E.	Mrs. C. L. Salmon, Nevada City	----	----
Bokay Bonanza	----	----	----	----	----	XX, p. 357
Boreham	----	----	----	----	----	See Grass Valley-Boreham
Boss Cons. (copper)	1, 12 7, 6	17 N. 17 N.	7 E. 8 E.	F. W. Bradley, 1022 Crocker Bldg., San Francisco	41	Bull. 50, p. 201-202; M. M. R. Nev. Co., p. 83-84
Boston Ravine	----	----	----	----	----	See North Star
Boundary	----	----	----	----	----	XVII, p. 436
Bowery Lode	----	----	----	----	----	Reg. Mines; see Alcalde Mines
Bowser	1	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	----	----
Brackett Mine Lode	20	16 N.	9 E.	Helen McIntire Smith, 2635 Dwight Way, Berkeley	16	----
Bradley's Barite property	----	----	----	----	----	XX, p. 12, see Spanish Mine
Brickyard Lot (Pratt & Dubuque)	33, 34	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	4	Reg. Mines
Brockington Cons.	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	3	----
Brunswick	25, 36	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	27	Reg. Mines; VIII, p. 431-432; XII, p. 196; X, p. 381-382; XI, p. 274-275; XIII, p. 237; M. M. R. Nev. Co., p. 124-128; XX, p. 9-10; XXXI, p. 11
Buckeye Gp.	4	16 N.	9 E.	Hoge Dev. Co., A. W. Hoge, Agt., Nevada City	100	Reg. Mines; XIII, p. 237; M. M. R. Nev. Co., p. 128
Buckhorn, Wedge & Gem	13, 14	18 N.	10 E.	Otis Fellows, Mt. View, et al.	40	----
Buena Vista	2, 11	15 N.	8 E.	T. C. Dorsey, 2241 Rose St., Berkeley, et al.	12	M. M. R. Nev. Co., p. 128
Bullion Cons.	1, 2	15 N.	8 E.	Bullion Cons. Mng. Co., F. W. McNear, Agt., Russ Bldg., San Francisco	69	Reg. Mines; XIII, p. 237; M. M. R. Nev. Co., p. 128-129; XXXI, p. 11
Bull Run (copper)	6 31, 32	17 N. 18 N.	10 E. 10 E.	D. R. McKillican Estate, W. L. Mobley, Agt., Nevada City	21	----
Bunker Hill	21, 28	17 N.	8 E.	Fannie Cole Mitchell, Grass Valley	82	----
Bunker Hill	24	16 N.	7 E.	Mrs. R. L. Capps, Rough and Ready, et al.	15	----
Bunker Hill Cons.	1 35	15 N. 16 N.	8 E. 8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	14	----
Butterfly & Big Blue	17	16 N.	9 E.	Dr. E. L. Dow, Jr., 1540 San Pablo Ave., Oakland	32	See Mayflower
Cabin Flat	27	16 N.	8 E.	See Golden Center Mine	6	Reg. Mines; M. M. R. Nev. Co., p. 130; see Golden Center Gp.
Cadmus (Home)	11	16 N.	8 E.	----	----	Reg. Mines; XIII, p. 237-238; see Champion Gp.
Calcor	29	16 N.	8 E.	Mrs. W. J. Arthur, 325 Marshall St., Grass Valley	17	----
Caledonia	----	----	----	Geo. Calanan, 318 Coyote St., Nevada City	----	Reg. Mines; XIII, p. 238
California (Pittsburg & Pittsburg Ext.)	31	16 N.	8 E.	Calif. Mng. Co., c/o C. A. Nichols, 444 Mills Bldg., San Francisco, et al.	38	M. M. R. Nev. Co., p. 130-131; XVIII, p. 45
California Cons. Gp. (Gold Tunnel)	12, 13	16 N.	8 E.	Albert G. Allan, 606 6th St., Marysville, et al.	----	Reg. Mines; XIII, p. 246; M. M. R. Nev. Co., p. 131

California (Great Eastern)						XX, p. 358-359; XXXII, p. 197; see Great Eastern
California (Gold & Copper)	12, 13	15 N.	6 E.	California Gold & Copper Co., D. L. Evans, Agt., Malad City, Idaho	65	Bull. 50, p. 203, 197; XIII, p. 60; M. M. R. Nev. Co., p. 84
Calumet & California Mng. Co.				Sold 1918 to Sierra Asbestos Co.		M. M. R. Nev. Co., p. 131-132; see Fairview Mine
Camborne-Hayle				C. C. Van Loben Sels, Vorden		Reg. Mines; see Phoenix or Sneath & Clay
Cambridge	36	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	13	See Union Hill
Canada Hill Cons. (Charonatte included)	17	16 N.	9 E.	R. W. Gaylord, 2626 5th Ave., Sacramento	164	Reg. Mines; XIII, p. 238; M. M. R. Nev. Co., p. 132-133; XXXI, p. 11-12
Canadian Group		18 N. 17 N.	13 E.	(Formerly Mohawk, Montreal & Omaha in Meadow Lake district)		XX, p. 357; XXXII, p. 197
Canton	16, 20, 21	18 N.	11 E.			See Erie Con.
Canyon Creek	4	17 N.	11 E.	Redstone Mines Corp. (lapsed 1933)	41	VIII, p. 452; see Columbia Gp.
Carlisle (copper)	4	17 N.	13 E.		260	Bull. 50, p. 202; M. M. R. Nev. Co., p. 85
Carlyle Gp.	4 32	17 N. 18 N.	13 E. 13 E.	Metal Products Holding Corp., 391 Sutter St., San Francisco	20	XX, p. 350; XXVI, p. 102-103
Carr	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	11	
Carter Gp.						M. M. R. Nev. Co., p. 133
Cash In Dump						See Freeman
Cascaret						See Erie Con.
Cassidy Cons.	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	34	Reg. Mines; M. M. R. Nev. Co., p. 133-134
C.B.C.						XXXII, p. 189-204
Cedar	20, 29	14 N.	8 E.	F. S. Parker, Wolf Rt., Auburn		Reg. Mines; XII, p. 186; XIII, p. 238; M. M. R. Nev. Co., p. 134
Celia & Free Trade	9, 16	17 N.	11 E.	Miners' Foundry & Supply Co., Nevada City	41	M. M. R. Nev. Co., p. 134
Celina & Bates	23, 26	18 N.	11 E.	Dr. A. H. Tickell, Nevada City		
Centennial	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	20	Reg. Mines; XIII, p. 238; M. M. R. Nev. Co., p. 134; see Sultana
Centennial	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	17	Reg. Mines; XI, p. 280; XII, p. 186; XIII, p. 238; see Gold Point
Central & Gray Eagle Gp.	2, 11	17 N.	11 E.	Katherine B. Ostrander, c/o John R. Wilson, Agt., 1032 Mills Bldg., San Francisco		Reg. Mines; XIII, p. 238; M. M. R. Nev. Co., p. 134; see Yuba Cons.
Central & Jim	22, 23	18 N.	11 E.			See Jim Cons.
Central Cons.	28	16 N.	9 E.	Lava Cap Gold Mng. Corp., O. E. Schiffner, general manager, Nevada City	13	XXXI, p. 13, 16-17
Central North Star	3	15 N.	8 E.	Empire Star Mines Co.		XI, p. 277; XII, p. 187; XIII, p. 238-239; M. M. R. Nev. Co., p. 134; see North Star
Central Pacific						Reg. Mines; XII, p. 187; XIII, p. 239
Central Shaft	34	16 N.	8 E.	Empire Star Mines Co.		Reg. Mines
Central South Yuba						M. M. R. Nev. Co., p. 135
Champion		16 N.	11 E.			VIII, p. 441-442
Champion	1 35	15 N. 16 N.	8 E. 8 E.	B. F. Berriman, Grass Valley	18	
Champion Gp.	2, 11 12, 13 14	16 N.	8 E.	Carl P. Jones, Grass Valley	440	VI, pt. 2, p. 47; VIII, p. 420; X, p. 386-387; XI, p. 286-287; XII, p. 187-188; XIII, p. 239; M. M. R. Nev. Co., p. 135-143; XVII, p. 435-436; XXVI, p. 103-104

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Charleston	17	16 N.	8 E.	Empire Star Mines Co., Ltd., Nevada City		
Charonatte						See Canada Hill
Chase						VIII, p. 452-453
Chesapeake	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	5	
Chicago	18, 19	16 N.	9 E.	Chicago Qutz. Mng. Co., Geo. A. Legg, Agt., Nevada City	21	
Christopher Columbus Cons.	25, 26	16 N.	8 E.	Marie Haub Koehler, 1476 19th Ave., San Francisco, et al.	21	See Golden Gate Gp.
Cincinnati Hill	28, 33	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	24	M. M. R. Nev. Co., p. 143; Reg. Mines; see North Star
Cleveland	1	15 N.	8 E.	M. S. White, Grass Valley		See Original Ben Franklin Cons.
Coan	3	16 N.	8 E.	Thomas N. Coan, Nevada City	21	Reg. Mines; XIII, p. 239; M. M. R. Nev. Co., p. 143-144
Codd (chrome)	21	16 N.	8 E.			M. M. R. Nev. Co., p. 71
Coe	27	16 N.	8 E.			X, p. 384; M. M. R. Nev. Co., p. 144; Reg. Mines
Colling						M. M. R. Nev. Co., p. 144
Columbia Gp.	4, 9	17 N.	11 E.		89	Reg. Mines; M. M. R. Nev. Co., p. 144-146; XXXI, p. 13
Comet	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley, et al.	11	See Conlon
Congo	10	15 N.	8 E.			XIII, p. 239; M. M. R. Nev. Co., p. 146; see Sultana
Conlon	1	15 N.	8 E.			Reg. Mines; XI, p. 283; XII, p. 187-189; XIII, p. 239; M. M. R. Nev. Co., p. 146-147
Confidence						XXXII, p. 197
Connecticut	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	18	
Consolidated (Delhi)	21	18 N.	9 E.			See Delhi
Consolidated Wyoming						VI, pt. 2, p. 48-49; see Champion
Constitution	9, 10	16 N.	9 E.	Mrs. Jessie R. Tautphaus, Apt. 5, 2460 Larkin St., San Francisco, et al.	21	XIII, p. 249; M. M. R. Nev. Co., p. 149; XVIII, p. 143; see National
Consols	10	16 N.	9 E.	Jacob Weissbein, Hobart Bldg., San Francisco, et al.	3	See Federal Loan
Copper Claim	25, 26 35	15 N.	6 E.	James G. Berryhill, 304 New Call Bldg., San Francisco	50	
Corinth Cons.	13	16 N.	8 E.	Iola Gillespie, R.F.D. 2, Grass Valley		
Cotton King, Lent & January	11	17 N.	10 E.	J. H. Stark, 2340 Lakeshore Blvd., Oakland, et al.	19	See Sierra Asbestos Co.
Cracker Jack	14	18 N.	10 E.	Wm. Buck, R.F.D., Lincoln, et al.	30	
Croesus Cons.	2, 3	15 N.	8 E.	Grass Valley Cons. Gold Mines, 209 Cap. Natl. Bk. Bldg., Sacramento	34	See Allison Ranch
Crown Point (Wm. Penn)	26	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	19	Reg. Mines; VIII, p. 429-431; XIII, p. 239-240; M. M. R. Nev. Co., p. 149

Culbertson	8	18 N.	11 E.			Reg. Mines; XII, p. 188; XIII, p. 240; M. M. R. Nev. Co. p. 149-150
Cyane	9, 10	16 N.	9 E.	Mrs. Jessie R. Tautphaus, Apt. 5, 2460 Larkin St., San Francisco, et al.	12	See Constitution
Daisy Hill	1	15 N.	8 E.	Empire Star Mines Co., Ltd., No. Star Mine, Grass Valley	20	XIII, p. 240; M. M. R. Nev. Co., p. 150
Daisy King & Golden Shore	14	15 N.	8 E.	Estate of J. T. Hennessey, Grass Valley, et al.	28	
Dakota	34	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	6	Reg. Mines; M. M. R. Nev. Co., p.150
Dam End						XXXII, p. 189-204
Dandarine	16, 20, 21	18 N.	11 E.			See Erie Cons.
Davey (chrome)	26	16 N.	8 E.		40	M. M. R. Nev. Co., p. 71-72
Daybreak & Freedom	9	16 N.	9 E.	J. C. Norton, Nevada City, et al.		
Deadwood	9	16 N.	9 E.	Deadwood Gold Mng. Co., J. M. Hadley, Secy., Hotel Coit, 15th and Harrison, Oakland	21	Reg. Mines; XIII, p. 240; M. M. R. Nev. Co., p. 150-151
Debarnardi	3	16 N.	8 E.	Thos. N. Coan, Nevada City		
Dee, Don & Dale	8, 9, 16, 17	17 N.	11 E.		62	See Washington (German) Con.
Deer Creek	11, 14	16 N.	8 E.	Carl P. Jones, Nevada City	15	See Champion Gp.
Defiance	24	16 N.	8 E.	Mrs. L. Ellenwood, Agt., 2424 Divisadero St., San Francisco	18	See Merrimac
Defiance Gp.		18 N.	9 E.	Estate of Phillip Curnow, North Columbia		XXVI, p. 104
Delhi	20, 21	18 N.	9 E.	Louis Nonnemann, 575 Dewey Blvd., San Francisco	21	Reg. Mines; VI, pt. 2, p. 50-51; VIII, p. 444-447; XI, p. 305-307; XII, p. 188; XIII, p. 241; M. M. R. Nev. Co., p. 147-149; XVII, p. 436; XXXI, p. 13
Democrat (barium)	24	16 N.	10 E.	Chemical & Pigments Co., Inc., 766 50tn Ave., Oakland	20	M. M. R. Nev. Co., p. 71; XVII, p. 434-435; XX, p. 12; XXVI, p. 53, 91-94
Dewey Electrum & Pinnacle	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	30	
Diamond	5, 6	15 N.	8 E.	Mattie Gold Mng. Co., Grass Valley		See Alcalde Mines
Diamond						XIII, p. 241; Reg. Mines
Diamond	2	15 N.	8 E.			Reg. Mines; XII, p. 188; XIII, p. 241; M. M. R. Nev. Co., p. 151; see Bullion Cons.
Diamond Creek	12, 13	17 N.	11 E.			Reg. Mines; VI, pt. 2, p. 44; X, p. 389; XII, p. 188; XIII, p. 241; M. M. R. Nev. Co., p. 151; see Eagle Bird Cons.
Diamond Mng. & Development Co.						XII, p. 188-189
Dickerson (chrome)	4	15 N.	8 E.			M. M. R. Nev. Co., p. 72
Dillon	16, 22	18 N.	11 E.			Reg. Mines; XIII, p. 241
Dinero Mng. Co.	11, 14, 15	17 N.	11 E.			M. M. R. Nev. Co., p. 151; see Yuba Cons.
Dodo	13	16 N.	8 E.	Claude Stark, Auzerais Bldg., Rm. 70, San Jose	3	See Mountaineer
Doolittle						See Penn California
Dorsey & Ridge (chrome)	6	15 N.	8 E.		80	M. M. R. Nev. Co., p. 72
Dromedary	27	16 N.	8 E.			See Golden Center Gp.
Dublin Bay Cons.	21	18 N.	11 E.		41	Reg. Mines; see Erie Cons.
Dull						See Empress
Dulmaine	31, 32	16 N.	8 E.			See Normandie Dulmaine Gp.
Dutretre Gp.	12, 13	17 N.	11 E.			M. M. R. Nev. Co., p. 151

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.				
Eagle	7	16 N.	9 E.	Al Seaman, Nevada City	6	
Eagle Bird Cons.	12, 13	17 N.	11 E.	Eagle Bird Mines, Inc., Geo. G. Thomas, Bagdad Copper Corp., Hillsdale, Arizona	119	Reg. Mines; VI, pt. 2, p. 51; VIII, p. 440; X, p. 389-391; XII, p. 188; XIII, p. 241; M. M. R. Nev. Co., p. 152; XX, p. 10; XXVI, p. 104-105; XXXI, p. 13
East Home	11	16 N.	8 E.		18	See Champion Gp.
East Star	32	16 N.	8 E.	Mrs. Lillie M. Baird, R.F.D. 2, Grass Valley	18	
Eclipse	2, 11	15 N.	8 E.	Mrs. Mary Frank, E. Main St., Grass Valley	15	Reg. Mines; M. M. R. Nev. Co., p. 154
Eclipse	5	15 N.	8 E.	Mattie Gold Mg. Co., Grass Valley (suspended 1933)		See Alcalde Mines
Edison	21	18 N.	11 E.		9	See Ancho
Edison	4	17 N.	13 E.			XX, p. 358
Electric						See Sultana
Emmet						See North Star
Emily	17	16 N.	9 E.	John B. Bennett, Grass Valley	17	
Empire	26, 27 34, 35	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley, John R. C. Mann, general manager	430	Reg. Mines; VI, pt. 2, p. 46-47; VIII, p. 426-428; X, p. 371-372; XI, p. 272-273; XII, p. 189; XIII, p. 242; M. M. R Nev. Co., p. 154-162; Pre. Rep. 8, p. 31; XVII, p. 436; XVIII, p. 140; XX, p. 140; XXVI, p. 105-110
Empire West	2, 3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley		VIII, p. 433; X, p. 373; XI, p. 272-273, 284; XII, p. 197; XIII, p. 258; M. M. R. Nev. Co., p. 162-164
Empress (Dull or Newtown)	8, 17	16 N.	8 E.			XVIII, p. 140; XXXI, p. 13
English Mtn.	6	18 N.	13 E.	*Estate of H. C. Schroeder, Nevada City	105	M. M. R. Nev. Co., p. 85, 164; XIII, p. 242
Enterprise	20, 21	18 N.	9 E.	Enterprise Mng. Co., C. S. Paine, 4423 Morgan Ave., Oakland	17	VIII, p. 447; XI, p. 306-307
Enterprise	20	16 N.	9 E.	Dr. E. L. Dow, Jr., 1540 San Pablo, Oakland		See Mayflower
Erie Cons.	16, 20 21	18 N.	11 E.	Calif. Erie Co., Ancho-Erie Mng. Co., Agt., Graniteville	234	Reg. Mines; XI, p. 300; M. M. R. Nev. Co., p. 165-166
East Eureka	26	16 N.	8 E.	Idaho Maryland Mines Co., Grass Valley	2	
Ethel & So. Ethel	34, 35	18 N.	11 E.	Calif. Lands, Inc., Capitol Co., Agt., 625 Market St., San Francisco, et al.	40	Reg. Mines; XII, p. 189; XIII, p. 242-243; M. M. R. Nev. Co., p. 166
Eureka Cons. (Roannaise)	23, 26	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	44	Reg. Mines; M. M. R. Nev. Co., p. 166-167
Eureka Cons. (copper)	1, 12	15 N.	6 E.	Mary Mooney, Agt., Smartsville		M. M. R. Nev. Co., p. 85
Excelsior	21	18 N.	9 E.		17	See Delhi
Excelsior	27	18 N.	13 E.			Reg. Mines; VIII, p. 454; XIII, p. 243; M. M. R. Nev. Co., p. 168; XX, p. 357-358, 361-362; XXXII, p. 189-204
Fair Play	2	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	11	
Fahey						See North Star

Fairview (copper)	2	17 N.	10 E.		160	Bull. 50, p. 202; M. M. R. Nev. Co., p. 168
Federal Loan & Consols	9, 10	16 N.	9 E.	Jacob Weissbein, Hobart Bldg., San Francisco, et al.	20	Reg. Mines; XI, p. 290; XII, p. 189; XIII, p. 243; M. M. R. Nev. Co., p. 169
Fillmore	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	14	Reg. Mines; see Sultana
Forest	3	16 N.	8 E.	Willis Green, Nevada City		XIII, p. 243
Forlorn Hope	23	16 N.	7 E.			Reg. Mines; XIII, p. 244; see Black Bear
Fortuna						See Mountaineer
Fountain Head (& Eureka Placer)	9, 10 15, 16	18 N.	11 E.	Rohte Estate, O. L. Rohte, Agt., 2608 Webster St., San Francisco	400	
Fourth of July						XX, p. 358
Fraction						XXXII, p. 189-204
Frankford	5, 6	15 N.	8 E.	Marie Haub Kaehler, 1476 19th Ave., San Francisco	18	See Vulcan
Franklin (Ford)	2	15 N.	8 E.	Allison Ranch Ford Mng. Co., Gertrude M. Ford, Agt.	15	See Allison Ranch
Frederick						See Coan
Freeman Gp.	27	18 N.	13 E.			XX, p. 358
Friendly Peace		17 N.	11 E.			XIII, p. 244; Reg. Mines
Gambler Gold & Silver	25, 26	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley		
Gambrinus	27	18 N.	11 E.	Gaston Gold Mines, Ltd., H. A. Moss, 82 Sutter St., San Francisco	20	Reg. Mines; VIII, p. 448; XII, p. 189; XIII, p. 244; see Gaston Ridge Cons.
Garage	27	16 N.	8 E.			M. M. R. Nev. Co., p. 170; see Golden Center
Gaston Ridge Cons.	21, 22 27, 28	18 N.	11 E.	Gaston Gold Mines, Ltd., H. A. Moss, 82 Sutter St., San Francisco	164	VIII, p. 448-450; XI, p. 308-309; XII, p. 189; XIII, p. 244; M. M. R. Nev. Co., p. 170-173; XXVI, p. 110-113
Gautier Ranch (copper)	28, 29	14 N.	8 E.		320	Bull. 50, p. 203; M. M. R. Nev. Co., p. 86
Geach Property (chrome)	25	16 N.	8 E.		10	M. M. R. Nev. Co., p. 72-73
General Grant	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	3	
General Grant	14	15 N.	8 E.	General Grant Mng. Co., Gertrude M. Ford, Agt.	28	M. M. R. Nev. Co., p. 173
General Miles	16, 21	18 N.	11 E.	Golden Triangle Ltd., Chas. Mason, Agt., Graniteville	21	
Geo. Washington, Abraham Lincoln & Geo. Dewey	6	18 N.	13 E.	Jennie A. Schroeder, Nevada City	59	
German	12	17 N.	11 E.			Reg. Mines; XIII, p. 244; see Bluebell
German Bar Cons.	11, 12	18 N.	10 E.	German Bar Gold Mines, Inc., No. Bloomfield	36	
Giant King	13	17 N.	10 E.	Jack A. Graves		Reg. Mines; XIII, p. 245; M. M. R. Nev. Co., p. 173
Gladstone	3 34	15 N. 16 N.	8 E. 8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley		M. M. R. Nev. Co., p. 173
Gladstone	25	16 N.	8 E.	J. D. Coughlin, Nevada City, et al.		
Glencoe	17, 18 20	16 N.	9 E.	A. Nivens, Sr. Estate, Nevada City	13	Reg. Mines; XIII, p. 245; M. M. R. Nev. Co., p. 173-174
Glenn						Reg. Mines; XIII, p. 245; see Rocky Glenn
Gold Bank Tunnel Co.						XIII, p. 245
Gold Bar	28, 33 34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley	17	Reg. Mines; see North Star
Gold Blossom	36	16 N.	8 E.	Carroll McA. Thomas, Auburn St., Grass Valley	10	

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Golden Center Gp.	27	16 N.	8 E.	Cooley Butler, 744 Title Ins. Bldg., Los Angeles	150	XIII, p. 235; XX, p. 10, 179; M. M. R. Nev. Co., p. 177-180; XXXI, p. 13-14
Golden Chain						See Syndicate Cons.
Golden Eagle						XXXII, p. 197
Golden Gate Gp. (Kentucky & Alpha)	25, 26	16 N.	8 E.		19	Reg. Mines; M. M. R. Nev. Co., p. 180-182, 73
Golden Gate	9	17 N.	11 E.	Star Mng. Co., Grass Valley	42	See Starr Gp.
Golden Lily Gp. (Golden Lead, Silver Pick, Buckskin & Red Rock)	1	15 N.	8 E.	F. W. Hooper, Grass Valley	91	
Golden Star Lode	11	15 N.	8 E.	Estate of J. T. Hennessy, Grass Valley	12	
Gold Flat (Mohigan)	13, 18	16 N.	8 E.	Mohigan Gold & Silver Mng. Co., Ben Hall, Agt., Nevada City	29	Reg. Mines; XI, p. 293-294; XII, p. 189-190; XIII, p. 245; M. M. R. Nev. Co., p. 198; see Pittsburg Gp.
Gold Hill	27, 34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley		M. M. R. Nev. Co., p. 174; Reg. Mines; see North Star
Gold Hill	11	16 N.	8 E.			VI, pt. 2, p. 49; VIII, p. 418; X, p. 378; XII, p. 190; XIII, p. 235; see Champion
Gold King						M. M. R. Nev. Co., p. 174
Gold Mound (Boyle & Roach Placer)	29	16 N.	8 E.			M. M. R. Nev. Co., p. 174-176; XX, p. 10
Gold Point	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley, et al.	21	Reg. Mines; XIII, p. 245-246; M. M. R. Nev. Co., p. 176-177
Gold Run	19, 22, 23	17 N.	13 E.	Towle Bros., Agt., 304 Berkeley Bank Bldg., Berkeley		XXXII, p. 197
Gold Run Cons.	1	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	32	
Gold Tunnel	12, 13	16 N.	8 E.			See Calif. Cons. Gp.
Gold Wedge						XVIII, p. 142; XX, p. 10
Goodall Cons.	1	15 N.	8 E.	Chas. W. Kitts, 1248 25th Ave., San Francisco	107	Reg. Mines; XIII, p. 246; M. M. R. Nev. Co., p. 182-183
Good Hope						See Scotia
Goodyear						See Gambrinus
Gould & Curry	5, 6	15 N.	8 E.			See Alcalde Mines
Gould Mound						See Gold Mound
Gracie	18	16 N.	9 E.	F. L. Arbogast, Agt., 202 P.O. Bldg., Oakland		M. M. R. Nev. Co., p. 183; XXVI, p. 113
Grafton						VIII, p. 440
Granite Hill	34	16 N.	8 E.			Reg. Mines; XIII, p. 246; see North Star
Grant	25, 26	16 N.	8 E.	Home Mng. Co., Mrs. Josie Spargo, Agt., Grass Valley	7	Reg. Mines; M. M. R. Nev. Co., p. 183
Grant & Canada Hill Mng. Co.	17	16 N.	9 E.			XII, p. 190; XIII, p. 246; see Canada Hill Cons.
Grass Valley-Boreham Gold Mng. Co.						XXVI, p. 113-114
Grass Valley Gold Mines						See Alta Hill
Gray Eagle	2, 11	17 N.	11 E.	Katherine B. Ostrander, c/o John R. Wilson, Agt., 1032 Mills Bldg., San Francisco		Reg. Mines; see Central Gp.
Great Bear, Grey Eagle & Springer	22, 23, 24	18 N.	9 E.	Grizzly Ridge Mine, Inc., Mrs. Paul Andrews, Box 400, Nevada City		

Great Britain	34	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	5	Reg. Mines; see North Star
Great Eastern Claims	4, 9	17 N.	10 E.	Western Gold, Inc., C. E. Clark, Mgr., Relief Hill		
Great Eastern Gp. (Calif.)						See California
Great Eastern & Great Western Gp.						XXXII, p. 189-204
Great Northern						See Hoge
Greely Blackman	15	16 N.	8 E.			Reg. Mines
Green	1 35	15 N. 16 N.	8 E. 8 E.	Empire Star Mines Co., Ltd. Empire Mine, Grass Valley	½	
Green Emigrant						XXXII, p. 197
Greenhorn						XXXII, p. 197
Greenhorn Creek	19	16 N.	10 E.	Greenhorn Creek & Mammoth Mng. Co., Quaker Hill Gold Mng. Corp., Nevada City	17	
Greenman	17, 20	16 N.	9 E.	Dr. E. L. Dow, Jr., 1540 Pablo Ave., Oakland	5	See Mayflower
Green Mountain	1 35	15 N. 16 N.	8 E. 8 E.			VIII, p. 433; XI, p. 285; see Sultana
Grey Eagle	25, 34	18 N.	13 E.	R. C. Campbell, 837 Paloma Ave., Oakland	20	XIII, p. 247; M. M. R. Nev. Co., p. 184
Greystone Gp.	25	18 N.	10 E.	Chas. Hegarty, Agt., 1450 Clay St., San Francisco		Reg. Mines; XIII, p. 247
Grizzly Ridge Claim				United Grizzly Ridge Mng. Co., C. J. Schuster, Agt., Pike City		Bull. 50, p. 204; XI, p. 307-308; M. M. R. Nev. Co., p. 184
Grover Cleveland	2	15 N.	8 E.	Margaret Keleher, 118 S. School St., Grass Valley, et al.	13	
Grub Stake						XIII, p. 247
Haiselton	1	15 N.	8 E.	Mrs. R. E. McCabe, 447 S. Auburn St., Grass Valley	9	
Haphine	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	13	See Gold Point
Harrison, Bryant & Olcott	36	17 N.	7 E.	Luke Williams, Grass Valley		
Hartery Cons.	2, 3	15 N.	8 E.	The Hartery Cons. Mng. Co., Leland Mitchell, Agt., Grass Valley, et al.	13	Reg. Mines; X, p. 378-379; XI, p. 283; XII, p. 190; XIII, p. 248; M. M. R. Nev. Co., p. 184
Hathaway Ledge	11	17 N.	11 E.	John R. Wilson, Agt., 1032 Mills Bldg., San Francisco, et al.	5	See Yuba Cons.
Helen D.	6	18 N.	13 E.			See Marguerite Cons.
Henrietta						Reg. Mines; XIII, p. 248
Hermosa	33	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	15	Reg. Mines; XI, p. 280-281; see North Star
Heuston Hill						Reg. Mines; see Sultana
Hickson	20	16 N.	9 E.	Dr. E. L. Dow, Jr., 1540 San Pablo Ave., Oakland		See Mayflower
Hidden Treasure	5	15 N.	8 E.	The Mattie Gold Mng. Co., Grass Valley		See Alcalde Mines
High Grade Gp.	3, 4	17 N.	13 E.			M. M. R. Nev. Co., p. 185; XX, p. 359; see Eagle
Hilda & Ragon	3	16 N.	8 E.	Robert Nye, Nevada City	36	
Hill Lode	3	15 N.	8 E.	Grass Valley Cons. Gold Mines, 209 Cap. Natl. Bk. Bldg., Sacramento	9	
Hirschman & Grover	1, 12	16 N.	8 E.	Grover & Co., Mrs. K. Williamson, Agt., Nevada City	64	XIII, p. 255; M. M. R. Nev. Co., p. 96
Hocking Ranch						See Premier
Hoeft Lease (chrome)	11	16 N.	8 E.	Isabelle C. Sherman		M. M. R. Nev. Co., p. 73-74
Hoge	4	16 N.	9 E.	Great Northern Gold Mines, Inc., A. W. Hoge, Agt., Nevada City	138	XXXI, p. 15

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Holland	21	18 N.	11 E.		26	See Erie Cons.
Holseman (chrome)	22	16 N.	8 E.	W. Holseman, Grass Valley	34	M. M. R. Nev. Co., p. 74
Home	33	16 N.	8 E.	Home Mng. Co., Mrs. Josie Spargo, Agt., Grass Valley	7	See Grant
Home	20	17 N.	9 E.			Reg. Mines
Home (Deer Creek)	11, 14	16 N.	8 E.	Carl P. Jones, Grass Valley	10	Reg. Mines; XII, p. 190; XIII, p. 248; see Champion Gp.
Homestake	35	17 N.	8 E.	J. M. Hadley, 4th St. and Princess, Brandon, Manitoba, Canada, et al.	6	
Home Ticket	3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	6	
Homeward Bound	2, 3	15 N.	8 E.		3	Reg. Mines; X, p. 382-383; XI, p. 282; see Empire West
Hooper, A. E. (chrome)	19	16 N.	9 E.		75	M. M. R. Nev. Co., p. 74
Hopkins	2, 3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	½	
Horseshoe	2	15 N.	8 E.			Reg. Mines
Houston Hill	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	15	See Sultana
Howard Hill	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	11	
Hudson Bay	33	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	7	XI, p. 282
Hughes	14	16 N.	8 E.	Eugene F. Hughes, R.F.D. 2, Grass Valley		
Hussey Ledge	4	16 N.	9 E.	Henry H. Hussey, Nevada City, et al.		
Idaho Maryland	25, 26	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley and San Francisco		Reg. Mines; VI, pt. 2, p. 45-46; VII, p. 425-426; X, p. 372-373; XI, p. 271-272, 283-284; XII, p. 192; XIII, p. 251; M. M. R. Nev. Co., p. 185-191; Pre. Rep. 8, p. 31; XVII, p. 436; XVIII, p. 140; XIX, p. 73; XX, p. 10, 179; XXVI, p. 114-118; XXXI, p. 15-16
Illinois						See Empire West
Illinois Cons.	15, 16	18 N.	11 E.	D. C. Heger, 444 Post St., San Francisco, et al.	11	See Rocky Glen
Income & Indiana	3	15 N.	8 E.	John S. Moore, R.F.D. 1, Box 3, Grass Valley	38	
Independence	17	16 N.	9 E.			See Canada Hill Cons.
Independence	25	16 N.	8 E.	Estate of D. Fricot, Angels Camp	18	Reg. Mines; XIII, p. 248; M. M. R. Nev. Co., p. 192
Indiana	1	15 N.	8 E.	M. S. White, Grass Valley	11	Reg. Mines; see Ben Franklin
Indiana	4, 6	15 N.	8 E.			See Alcalde Mines
Indian Boy						XXXII, p. 197
Inkerman	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	12	See Inkmarque Gp.
Inkmarque Gp.	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	40	XIII, p. 249; M. M. R. Nev. Co., p. 192
Iowa, Nob Hill & Contact	13	15 N.	6 E.	Mrs. Virginia Hughes, Wheatland	36	

Iowa Cons.	10, 14 15, 22 23	18 N.	11 E.	Fanny Milocek, 1505 West St., Oakland	122	See Birchville
Ironclad						Pre. Rep. 8, p. 31
Iron-Copper	31	15 N	8 E.	C. H. Taylor, Grass Valley, et al.		
Iron Mountain (iron)	4	15 N.	7 E.			Bull. 50, p. 203; M. M. R. Nev. Co., p. 262-263
I. X. L.	28	18 N.	11 E.	H. R. McNoble, Atty., Box 435, Stockton, et al.	21	M. M. R. Nev. Co., p. 192-193
Jack Rabbit Mill & Mng. Co.	32	16 N.	9 E.			XI, p. 278-279; XII, p. 190; XIII, p. 248
Jefferson Cons. (Jefferson & Winding Lode)	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	30	See Conlon
Jeremiah	4, 9	16 N.	9 E.	Caribino Orzalli, Nevada City	13	
Jesse Cons.	9, 10	16 N.	9 E.			XIII, p. 249; see Constitution
Jewell Cons.	9, 10	16 N.	9 E.	Mrs. Jessie R. Tautphaus, Apt. 5, 2460 Larkin St., San Francisco	22	See Constitution
Jim Cons.	22, 23	18 N.	11 E.	Jim Cons. Quartz Mine, C. G. Columbus, 14531 Victory Blvd., Van Nuys	27	
Johanna	9, 10	17 N.	13 E.	Julius Adolph, 1282 23d Ave., San Francisco	19	See Sylvanite
Johnson	5, 6	15 N.	8 E.			See Alcalde Mines
Johnson (antimony)	25	15 N.	8 E.			M. M. R. Nev. Co., p. 67
Josephine Lode	1 36	15 N. 16 N.	8 E. 8 E.	Mrs. R. McGrath, c/o Geo. C. Radcliff, 1120 41st St., Sacramento		
Joseph Warren	8	16 N.	9 E.			XIII, p. 249
Josephine Helen	8	16 N.	9 E.	Empire Star Mines Co., Ltd., Grass Valley		
Jumbo						See Coats Cons. Placer
Kate Hays						see Oregon
Keller	8	18 N.	11 E.		140	M. M. R. Nev. Co., p. 193
Kellogg	17	16 N.	9 E.	Dr. E. L. Dow, Jr., 1450 San Pablo Ave., Oakland		See Mayflower
Kennebec Cons.	9, 15 16	17 N.	9 E.	Paine Bros., Nevada City		XXVI, p. 118
Kenosha						See Alcalde Mines
Kentuck & U. S. Grant	4, 9	17 N.	13 E.			Reg. Mines; XX, p. 359-360
Kentucky	25, 26	16 N.	8 E.	Foothill Farms, Inc., Grass Valley	6	see Golden Gate Gp.
Kentucky	4	17 N.	13 E.	Kentucky Mng. Co., J. W. Pauson, Agt., 391 Sutter St., San Francisco	6	
Keystone	2	15 N.	8 E.	Grass Valley Cons. Gold Mines, 209 Cap. Natl. Bk. Bldg., Sacramento	7	
King Bee	34	16 N.	8 E.			Reg. Mines
Kirkham	2	16 N.	8 E.			XIII, p. 249
Kilroy, Mathew	1	17 N.	8 E.	Nankervis & Co., Mrs. Rachel N. Moore, Agt., 2990 Jackson St., San Francisco		See Patterson Placer
King Hill	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley		See Osborne Hill
La Belle & McKinley	9, 10	16 N.	9 E.	Col. J. E. Magovern, Box 55, Granite Springs, N. Y.	13	XIII, p. 249; Reg. Mines
La Bruja						See Bullion Cons.
Lafayette (Conlon)	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	11	XI, p. 283; M. M. R. Nev. Co., p. 146-147
La Grande						Reg. Mines; XIII, p. 249
Lake						XXXII, p. 189-204

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* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Lamarque Cons.	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	28	See Inkmarque Gp.
Larimer						See North Star
Last Chance	21	18 N.	9 E.	Louis Nonnemann, 575 Dewey Blvd., San Francisco	20	See Delhi
Last Chance (copper)	12, 13	15 N.	6 E.	Chas. Staples, Spenceville, et al.	24	Bull. 50, p. 195; M. M. R. Nev. Co., p. 86
Last Chance	14, 23	17 N.	11 E.	Minerals Exploitation Trust, W. C. Wallace, Agt., 326 Chicago Ave., Oakland	21	Reg. Mines; XIII, p. 250; M. M. R. Nev. Co., p. 193
La Suetre	2	16 N.	8 E.			Reg. Mines
Lava Cap		16 N.	9 E.	Lava Cap Gold Mng. Corp., O. E. Schiffner, Agt., Nevada City		XXXI, p. 13, 16-17
Le Compton	9	16 N.	9 E.	E. J. N. Ott, Nevada City, et al.	12	M. M. R. Nev. Co., p. 194
Le Duc	6	15 N.	9 E.	Le Duc Gold Mng. Co., Grass Valley		M. M. R. Nev. Co., p. 194-195; XVII, p. 436
Liberty Hill & Noon Summer	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	14	Reg. Mines; see Pennsylvania
Limekiln (chrome)	4	14 N.	8 E.			See Wolf
Lincoln Cons.	17	16 N.	9 E.	Austin Cagney, 1372 21st Ave., San Francisco	76	
Linden	35	16 N.	8 E.			See Cassidy Cons.
Lindsay						Reg. Mines; XIII, p. 250; see Yuba Cons.
Little Done	17	16 N.	9 E.	St. Louis Mine, Elizabeth C. Barker, Agt., Santa Maria del Oro, Durango, Mexico, via Rosario	18	See St. Louis Mine
Little Task	13	16 N.	8 E.	Annie R. Byrne, Townsend St., Grass Valley		
Live Oak						XXXII, p. 197
Live Oak & Minuet		18 N.	9 E.	United Grizzly Mng. Co., C. J. Schuster, Agt., Pike City		Reg. Mines; XII, p. 191; XIII, p. 250
Live Oak Cons.	26	14 N.	7 E.	Estate of Andrew J. Bobo, Wolf	35	
Live Yankee						See Mountaineer
Lode Star	3	15 N.	8 E.			Reg. Mines
Lone Jack (Omaha)	2, 3	15 N.	8 E.		10	See Omaha
Lone Ridge						Reg. Mines; XIII, p. 250; see Empire West
Lone Star	9, 16 17	16 N.	9 E.			Reg. Mines; XIII, p. 250; see Murchie
Lone Star Cons.	4	16 N.	9 E.	Hoge Development Co., A. W. Hoge, Agt., Nevada City	7	
Lost Hope Gp.	33	18 N.	13 E.			XX, p. 360
Lotzen Ranch (copper)	2	14 N.	7 E.		158	Bull. 50, p. 204; M. M. R. Nev. Co., p. 86
Loutzenheiser Tract	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	161	
Lucky	36	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	18	Reg. Mines; see Union Hill
Lucky Al Cons.	27, 34	18 N.	11 E.	Lois J. Brooks, 2131 You St., Sacramento	38	

Madison Hill	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	17	Reg. Mines; see Sultana
Magenta	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	22	
McKay	35	16 N.	8 E.			Reg. Mines
Malony & Fouch						Reg. Mines; XIII, p. 250-251
Mammoth Gp.	4	17 N.	13 E.			Bull. 50, p. 195; M. M. R. Nev. Co., p. 195; XXXII, p. 189-204
Mammoth Gold Copper	12	17 N.	7 E.		60	Bull. 50, p. 204; M. M. R. Nev. Co., p. 87
Manhattan						Reg. Mines; see Goodall Cons.
Manhattan	18	16 N.	9 E.	D. W. Baldwin, Grass Valley	13	
Maple	5	16 N.	9 E.			Reg. Mines
Marguerite Cons.	6	18 N.	13 E.	Jennie A. Schroeder, Nevada City	40	See English Mtn.
Marietta	2, 11	17 N.	11 E.	Katherine B. Ostrander, John R. Wilson, Agt., 1032 Mills Bldg., San Francisco	13	See Yuba Cons.
Mary Ann	3	15 N.	8 E.	Grass Valley Cons. Gold Mines, 209 Cap. Natl. Bk. Bldg., Sacramento	20	Reg. Mines; M. M. R. Nev. Co., p. 196
Maryland	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	24	
Mascot		16 N.	8 E.	Joseph E. Taylor, 245 E. Main St., Grass Valley		
Massachusetts	18	16 N.	9 E.			M. M. R. Nev. Co., p. 196
Massachusetts Hill	34	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	55	Reg. Mines; XIII, p. 251-252
Maule						See Ironclad
Maybert Gold Mines						See Yuba Cons.
Mayflower	17, 20	16 N.	9 E.	Dr. E. L. Dow, Jr., 1540 San Pablo Ave., Oakland		Reg. Mines; VIII, p. 453; XI, p. 295; XII, p. 192-193; XIII, p. 252-253; M. M. R. Nev. Co., p. 196-197
Mayflower	11	17 N.	11 E.	Katherine B. Ostrander, John R. Wilson, Agt., 1032 Mills Bldg., San Francisco	8	See Yuba Cons.
Mayflower, Dewey & Baltimore	5, 8	18 N.	11 E.	Ida M. Rudisill, 2851 E. 6th St., Los Angeles	62	See Keller
Merrifield	11, 12	16 N.	8 E.	Carl P. Jones, Grass Valley		VIII, p. 423-425; Reg. Mines; see Champion Gp.
Merrimac	24	16 N.	8 E.	Mrs. L. Ellenwood, Agt., 2424 Divisadero St., San Francisco		XI, p. 279-280; XII, p. 193; XIII, p. 253; M. M. R. Nev. Co., p. 197
Metropolitan	15	18 N.	10 E.	Mrs. Jennie Reynolds, Grass Valley, et al.	40	Reg. Mines; XIII, p. 253; M. M. R Nev. Co., p. 197-198
Mexican Cons.	19, 30	18 N.	11 E.		220	See Spanish
Midas & Yuba Mother Lode				Andy Fitz Mng. & Mlg. Co., 512 American Bk. Bldg., Oakland		
Mineral Hill (copper)	13	15 N.	6 E.	Chas. Staples, Spenceville, et al.		Bull. 50, p. 195-199; XII, p. 67; XIII, p. 60; M. M. R. Nev. Co., p. 87
Mineral King	8	16 N.	9 E.			Reg. Mines; XIII, p. 253
Minnesota	2, 3	15 N.	8 E.	Grass Valley Cons. Gold Mines, 209 Cap. Natl. Bk. Bldg., Sacramento	16	
Minnie	27, 28, 34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley	19	
Mistletoe	23	16 N.	7 E.	Mrs. C. J. Graham, Nevada City		Reg. Mines; XII, p. 193; XIII, p. 253; M. M. R. Nev. Co., p. 198
Mitchell Ranch						See Pioneer
Modoc	2	15 N.	8 E.	Jas. Benoit, Grass Valley, et al.	4	
Mohawk (antimony)		18 N.	10 E.			M. M. R. Nev. Co., p. 67

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Mohigan Gp. (Gold Flat)	13, 18	16 N.	8 E.	Mohigan Gold & Silver Mng. Co., Ben Hall, Agt., Nevada City	37	Reg. Mines; XII, p. 189-190; XIII, p. 253; M. M. R. Nev. Co., p. 198; see Pittsburgh
Monarch & Central Pacific		16 N.	7 E.			Reg. Mines; XII, p. 193; XIII, p. 253-254
Montana-Willow Valley Gp.	4	16 N.	9 E.	Hoge Development Co., A. W. Hoge, Agt., Nevada City	25	Reg. Mines; XIII, p. 254, 267; M. M. R. Nev. Co., p. 198-199; XVII, p. 439; see Penn-Calif. Placer
Monte Carlo						XX, p. 360
Monte Rio River	22	15 N.	9 E.	Bear River Water & Power Co., J. L. Rollins, Agt., Colfax	14	
Montreal	30, 31 6	18 N. 17 N.	10 E. 10 E.	Derbec Blue Gravel Mng. Co., V. J. A. Rey, Trustee, 215 Leidisdorff St., San Francisco	92	See Derbec Placer
Montreal						See Caledonia
Morehouse	26	16 N.	8 E.	Idaho Maryland Mines Corp., E. MacBoyle, Agt., Grass Valley	12	Reg. Mines
Morning Dew	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	20	
Morning Star Lode	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	½	
Morning Star Gp.	36	18 N.	8 E.	Herbert Curnow, Agt., Grass Valley		
Moscatelli, Bob (chrome)	1	17 N.	10 E.			M. M. R. Nev. Co., p. 75
Moscatelli, Pete (chrome)	1	17 N.	10 E.			M. M. R. Nev. Co., p. 75; Bull. 76, p. 157
Moscow						XXXII, p. 197
Mother Neal	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	21	
Mountaineer	12, 13	16 N.	8 E.	Claude Stark, Grant Bldg., Rm. 70, San Jose		Reg. Mines; X, p. 384-386; XI, p. 287-288; XII, p. 193-194; XIII, p. 254-255; M. M. R. Nev. Co., p. 200-202
Mountain Maid	14	15 N.	9 E.			Reg. Mines; see Mountain Maid Placer
Mountain View						Reg. Mines; XIII, p. 255
Mount Auburn	2	16 N.	8 E.	Mt. Auburn Mng. Co., Wm. G. White, Agt., Nevada City		Reg. Mines; XIII, p. 254; M. M. R. Nev. Co., p. 202
Mount George	10	16 N.	8 E.			Reg. Mines; XII, p. 193; XIII, p. 254
Mount Hill (chrome)	13	17 N.	10 E.			Bull. 76, p. 157; M. M. R. Nev. Co., p. 74
Mount Hope & Golden Age	15, 22	18 N.	11 E.	R. Winton, 112 Crescent Rd., San Anselmo	41	
Mount Vernon	20	17 N.	9 E.	Denton Kirkham & Ralph Kirkham, Star Rt., Nevada City		See Home Mine
Muller & Wallings	2, 11	16 N.	8 E.	Carl P. Jones, Grass Valley	18	See North Wyoming
Murchie	8, 9 16, 17	16 N.	9 E.	Empire Star Mines Co., Ltd., Grass Valley		XIII, p. 250; M. M. R. Nev. Co., p. 202-203; XXVI, p. 118-119; XXXI, p. 13
Mystery	19	16 N.	8 E.	Cooley Butler, 744 Title Ins. Bldg., Los Angeles	15	XXVI, p. 119
National Gp.	8, 17	18 N.	11 E.	D. R. McKillican Estate, W. L. Mobley, Agt., Nevada City	40	Reg. Mines; XI, p. 309; XII, p. 194; XIII, p. 255; M. M. R. Nev. Co., p. 204-205; see Republic

National	9, 10	16 N.	9 E.	Mrs. Jessie R. Tautphaus, Apt. 5, 2460 Larkin St., San Francisco		XI, p. 309-310; XII, p. 194; XIII, p. 255; M. M. R. Nev. Co., p. 203-204; see Constitution
Native Son Lode	18	16 N.	8 E.	John Kelly, Wildomar, et al.	18	
Neuralgaline & Lane	16, 20, 21	18 N.	11 E.			See Erie Cons.
Nevada	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	36	
Nevada City	2, 11	16 N.	8 E.	Carl P. Jones, Grass Valley		Reg. Mines; VI, pt. 2, p. 49-50; XI, p. 288-290; M. M. R. Nev. Co., p. 205; see Champion Gp.
Nevada Lode	17, 20	16 N.	8 E.	Mrs. Margaret V. Nolan, Grass Valley		
Nevada Co. (chrome)	11, 12	16 N.	8 E.			Reg. Mines; Bull. 76; p. 157-158; M. M. R. Nev. Co., p. 76, 81, 205
Never Give Up	9	16 N.	9 E.			Reg. Mines
Never Sweat	9	16 N.	9 E.	St. Louis Cons. Gold Mines Co., J. T. Hennessey, Agt., Grass Valley		Reg. Mines; XIII, p. 256; M. M. R. Nev. Co., p. 205-206; XVII, p. 438; see St. Louis Cons.
New Brunswick						See Idaho-Maryland
New Constitution, R. F. Grant Hay & Success	19	16 N.	8 E.	Randolph Cons. Claims, F. M. Miller, Agt., Grass Valley		
New Dorn Hill	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley		
New England Cons. Mines	13	16 N.	8 E.	A. R. Archibald, Trustee, Grass Valley		XXVI, p. 119-121
New Eureka		16 N.	8 E.			X, p. 381
New Hope						XXXII, p. 189-204
New Idea	27, 28	16 N.	8 E.	Grass Valley Boundary Mines Co., 250 S. Church St., Grass Valley	20	
New Mohawk Cons.	18	16 N.	9 E.	Ben A. Bost., Agt., Nevada City		
New Ophir	1	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	17	M. M. R. Nev. Co., p. 206
New Pittsburg		16 N.	8 E.			XI, p. 294; XII, p. 197; XIII, p. 256
New Providence		17 N.	9 E.			XIII, p. 256
New Rocky Bar	23	15 N.	8 E.			XI, p. 284; see North Star
Newtown	8, 17	16 N.	8 E.			XXVI, p. 121; see Empress
New Years & Climax	11, 12	16 N.	8 E.	Carl P. Jones, Grass Valley	15	See Champion Gp.
New York	8	16 N.	9 E.			See Texas
New York Hill	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	54	Reg. Mines
Niagara	18	16 N.	8 E.		60	XII, p. 256; M. M. R. Nev. Co., p. 206-207
Nichols Gp.	28	16 N.	8 E.	Carolina Preble, Grass Valley	14	Reg. Mines; M. M. R. Nev. Co., p. 207
Norambagua (Three Sevens) Gp.	11, 15	15 N.	8 E.	Grass Valley Gold, Inc., c/o A. R. Archibald, 128 High St., Grass Valley	79	Reg. Mines; XIII, p. 256-257; M. M. R. Nev. Co., p. 207-208; XVII, p. 436-437
Normandie Dulmaine Gp.	31, 32	16 N.	8 E.	The Mattie Gold Mng. Co., Grass Valley		Reg. Mines; XIII, p. 257; XII, p. 194; M. M. R. Nev. Co., p. 208-209; XVII, p. 437; XVIII, p. 141; XX, p. 10; Pre. Rep. 8, p. 31; XXVI, p. 121; XXXI, p. 16
North Banner Cons.	16	16 N.	9 E.	Lava Cap Gold Mng. Corp., O. E. Schiffner, Agt., Nevada City, et al.	31	Reg. Mines; VIII, p. 420-422; X, p. 387-389; XI, p. 296; XII, p. 194-195; XIII, p. 257; M. M. R. Nev. Co., p. 210

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* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
North Bloomfield (clay)	6	16 N.	9 E.			Bull. 99, p. 136-137, 329
Northern Bell Gp.	1, 12	15 N.	8 E.	Carroll McA. Thomas, Agt., Grass Valley	20	M. M. R. Nev. Co., p. 210-211
North Grant Cons.	17	16 N.	9 E.	R. W. Gaylord, 2626 5th Ave., Sacramento, et al.	33	
North Mammoth						XXXII, p. 189-204
North San Juan Mng. Co.						Reg. Mines; XIII, p. 257
North Star	2, 3 27, 28 34	15 N. 16 N.	8 E. 8 E.	Empire Star Mines Co., Ltd., Grass Valley	1200	Reg. Mines; VI, pt. 2, p. 44-45; VIII, p. 428-429; X, p. 376-378; XI, p. 270-271; XII, p. 195-196; XIII, p. 257; M. M. R. Nev. Co., p. 211-224; XVII, p. 437-438; XVIII, p. 140-141; XIX, p. 140; XX, p. 10, 179; Pre. Rep. 8, p. 31; XXVI, p. 121-127; XXXI, p. 13
North Star	9	17 N.	11 E.	Star Mng. Co., Grass Valley	21	See Starr Gp.
North Star		17 N.	11 E.			Reg. Mines; XIII, p. 257
North Wyoming	2	16 N.	8 E.	Carl P. Jones, Grass Valley	22	XI, p. 296; XII, p. 194; XIII, p. 255; M. M. R. Nev. Co., p. 224-225; see Champion Gp.
No. 3	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	2	
Norway		18 N.	11 E.			Reg. Mines; XIII, p. 257
Oak Flat	15, 22	18 N.	10 E.	Mrs. C. E. Landsburg, North Bloomfield, et al.	86	
Oakland	1	15 N.	8 E.	W. J. Geach, et al.	20	
Oakman Gp.	31	18 N.	11 E.	Pierra Hughes Co., South Dakota	320	M. M. R. Nev. Co., p. 225
Ocean Star (Cooley)	9	17 N.	11 E.	Redstone Mines Corp.	60	M. M. R. Nev. Co., p. 226; see Washington (German) Cons.
Of What Nos. 1 & 2						XXXII, p. 189-204
O. K.	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	13	
O. K. & Gold Bar	19	16 N.	9 E.			Reg. Mines
Old Home						XIII, p. 258
Old Houston	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	5	See Sultana
Omaha (& Lone Jack)	2, 3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	20	Reg. Mines; VIII, p. 433-434; X, p. 373-374; XI, p. 273-274; XII, p. 197; XIII, p. 258; see Empire West
Omaha		17 N.	13 E.			See Canadian Gp.
Omega	9	16 N.	9 E.	Mrs. J. H. Fogarty, 6127 California St., San Francisco	7	
Ophir						See Empire
Oregon (Kate Hays or Crescent)	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	6	Reg. Mines; XIII, p. 258
Original Ben Franklin Cons.	1	15 N.	8 E.	Ben Franklin Con. Mng. Co., M. S. White, Agt., Grass Valley	43	See Ben Franklin
Original Empire	2, 3	15 N.	8 E.			VIII, p. 426-428; X, p. 371-372; XI, p. 273; XII, p. 189; XIII, p. 258; see Empire

Original Pittsburg	13, 24	16 N.	8 E.	Anglo & London, Paris Natl. Bk. of San Francisco, H. Dasking, Agt.	-------	VIII, p. 426; XI, p. 294-295; XII, p. 197-198; see Pittsburg Gp.
Orion Cons.	10	18 N.	11 E.	John Pedemont, Box 567, Santa Cruz	-------	-------
Orleans	25, 34	18 N.	11 E.	-------	22	See Star Ledge Gp.
Orleans	1 35	15 N. 16 N.	8 E. 8 E.	-------	-------	VIII, p. 432-433; XII, p. 258-259; see Sultana
Orleans Cons.	13 18	16 N. 16 N.	8 E. 9 E.	Claude Stark, Rm. 70, Auzerais Bldg., San Jose	32	Reg. Mines; XIII, p. 259; see Mountaineer
Orleans No. 3 Lode	18	16 N.	9 E.	W. D. Chappel, R.F.D., Box 163, Nevada City	8	-------
Oro Fino	5	17 N.	8 E.	-------	-------	Reg. Mines; XIII, p. 259; see Sultana
Oro Fino	3	16 N.	8 E.	-------	-------	See Stanford
Oro Fino & Congo	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	-------	See Goodall Cons.
Oro Grande (copper)	27	18 N.	13 E.	-------	80	Bull. 50, p. 199; M. M. R. Nev. Co., p. 88
Oro Grande	-------	-------	-------	-------	-------	Reg. Mines; XIII, p. 259
Osborne Hill	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	46	XII, p. 198; XIII, p. 259; M. M. R. Nev. Co., p. 226-227; see Empire
Osceola	25 30	16 N. 16 N.	7 E. 8 E.	F. M. Miller, 262 S. Auburn St., Grass Valley	20	Reg. Mines; XII, p. 198; XIII, p. 259; M. M. R. Nev. Co., p. 227-228; XVIII, p. 142; XX, p. 11
Oustomah	1, 12	16 N.	8 E.	-------	168	M. M. R. Nev. Co., p. 228-229; see Pennsylvania
Oxford	5, 6	15 N.	8 E.	-------	-------	See Alcalde Mines
Pacific	-------	-------	-------	-------	-------	XXXII, p. 197
Paine Claims (mineral paint)	-------	-------	-------	-------	-------	XXVI, p. 137
Paine	-------	17 N.	9 E.	-------	180	M. M. R. Nev. Co., p. 229
Panama Lode	3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	10	-------
Parr	-------	-------	-------	-------	-------	See Pennsylvania
Peabody	27	16 N.	8 E.	Cooley Butler, 744 Title Ins. Bldg., Los Angeles	9	Reg. Mines; XII, p. 198; XIII, p. 260;XI, p. 275; M. M. R. Nev. Co., p. 229-230
Pennsylvania	1, 12	16 N.	8 E.	Rachel Moore, 2990 Jackson St., San Francisco, et al.	112	-------
Pennsylvania (& W. Y. O. D.)	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley	-------	X, p. 383-384; XI, p. 276-277; XII, p. 198; XIII, p. 260; M. M. R. Nev. Co., p. 230-234; see Empire
Perseverance & Live Yankee	13	16 N.	8 E.	Claude Stark, Auzerais Bldg., Rm. 70, San Jose	24	See Mountaineer
Philadelphia	5, 6	15 N.	8 E.	-------	-------	See Alcalde Mines
Phoenix	11	16 N.	9 E.	See Sneath & Clay	20	M. M. R. Nev. Co., p. 234
Phoenix Park	3	15 N.	8 E.	P. J. Riley, Grass Valley	-------	-------
Pine Hill (copper & gold)	12, 13	14 N.	7 E.	Ira J. Coe, 67 Santa Clara Ave., Oakland	160	Bull. 50, p. 199; Bull. 99, p. 137-138; M. M. R. Nev. Co., p. 88-89
Pine Tree	1 35	15 N. 16 N.	8 E. 8 E.	H. C. Berriman, Perrin Hotel, Lodi	4	-------
Pioneer	-------	-------	-------	-------	-------	XXVI, p. 127-128
Pittsburg Gp.	13, 24	16 N.	8 E.	Anglo & London, Paris Natl. Bk. of San Francisco, H. Dasking, Agt.	-------	Reg. Mines; XII, p. 189; XIII, p. 245; M. M. R. Nev. Co., p. 234-236
Plumas Lode	14	16 N.	8 E.	May McEwen, Box 304, Port Chicago, et al.	17	-------

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Plumas Nevada	14	16 N.	8 E.			Reg. Mines
Polaris	11	15 N.	8 E.	Dr. Geo. E. Chappell, 211 Physicians Bldg., Sacramento	10	Reg. Mines; M. M. R. Nev. Co., p. 236
Polar Star	4	15 N.	8 E.		120	M. M. R. Nev. Co., p. 237
Polinghorn						See North Star
Potosi	13	16 N.	8 E.	Anglo & London, Paris Natl. Bk. of San Francisco, H. Dasking, Agt.		See Pittsburg Gp.
Powning	26	16 N.	8 E.	A. F. Brady, 1243 Sutter St., San Francisco	20	Reg. Mines; M. M. R. Nev. Co., p. 237
Pratt & Dubuque (Brickyard Lot)	33, 34	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	4	
Premier						M. M. R. Nev. Co., p. 237
Prescott Hill	1 35	15 N. 16 N.	8 E. 8 E.	Empire Star Mines, Ltd., Empire Mine, Grass Valley	13	Reg. Mines
Providence	11, 12, 13	16 N.	8 E.	Carl P. Jones, Grass Valley	34	Reg. Mines; VI, pt. 2, p. 47-48; VIII, p. 418; XI, p. 290-291; XII, p. 198-199; XIII, p. 260; see Champion Gp.
Prudential	10	15 N.	8 E.			M. M. R. Nev. Co., p. 238
Purcell & Muller	15	18 N.	10 E.	Mrs. C. E. Landsburg, North Bloomfield, et al.	5	
Quartz Claim on Woods Ravine	2, 11	16 N.	8 E.	Carl P. Jones, Grass Valley	18	See Muller & Wallings Cons.
Queen Lil		16 N.	8 E.			XXVI, p. 128
Queen Regent (copper)						M. M. R. Nev. Co., p. 89
Ragon	2	16 N.	8 E.	Calif. Sierra Gold Mines, Inc.		XIII, p. 260-261; M. M. R. Nev. Co., p. 238-239; XXXI, p. 12
Railroad	9	16 N.	9 E.	Deadwood Gold Mng. Co., J. M. Hadley, Secy., Hotel Coit, 15th & Harrison, Oakland	7	See Deadwood
Rainbow Gold	34	16 N.	11 E.			Reg. Mines; XII, p. 199; XIII, p. 261
Randolph	32	17 N.	9 E.			See Western Merger
Randolph Cons. Gold Mng. Co.						XVIII, p. 142; XX, p. 10; see Gold Wedge
Redan						See Sultana
Red Cross Cons.	16	17 N.	11 E.	Miners' Foundry & Supply Co., Nevada City	79	
Red Hill	29	16 N.	8 E.	Mrs. W. J. Arthur, 325 Marshall St., Grass Valley	18	
Red Hill	11	16 N.	8 E.			Reg. Mines; XIII, p. 261
Red Hill Specimen		16 N.	8 E.			XIII, p. 261-263
Red Ledge Cons.	35, 36	17 N.	7 E.	South Yuba Mng. & Smelting Co., A. A. Ellenger, Agt., 863 41st St., San Francisco	107	Bull. 50, p. 200; M. M. R. Nev. Co., p. 89, 248-249 (South Yuba)
Red Ledge	12, 13	17 N.	10 E.	Williamson & Cole, Washington	150	Bull. 76, p. 158; XVII, p. 438; Pre. Rep. 8, p. 31; M. M. R. Nev. Co., p. 76-78, 239-240; XXVI, p. 95
Red Mtn. Gp. (copper)	17	17 N.	13 E.		640	Bull. 50, p. 200
Red Point	1	17 N.	10 E.		55	Reg. Mines; XIII, p. 262; M. M. R. Nev. Co., p. 240
Red Rose	18	16 N.	9 E.	Dr. E. L. Dow, Jr., 1540 San Pablo Ave., Oakland		See Mayflower
Republic	17	18 N.	11 E.	H. W. Meek Estate, Stuart Hawley, Agt., 703 Syndicate Bldg., Oakland	23	M. M. R. Nev. Co., p. 240-241; XX, p. 11; see National
Republic Gp.	6	15 N.	9 E.			M. M. R. Nev. Co., p. 241-242

Reward	13	16 N.	8 E.			XII, p. 199; XIII, p. 262
Reward Cons. Gold & Silver	13	16 N.	8 E.	Claude Stark, Rm. 70, Grant Bldg., San Jose	17	See Mountaineer
Richardson	2, 3, 10	17 N.	9 E.	Hammon Est. Co., Balfour Bldg., 351 California St., San Francisco, et al.		
Rip Van Winkle	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley		See Black Hawk
Rising Sun	2, 11	17 N.	11 E.	Katherine B. Ostrander, John R. Wilson, Agt., 1032 Mills Bldg., San Francisco	11	Reg. Mines; XIII, p. 262; see Yuba Cons.
Roannaise						See Eureka Cons.
Rock Roche	27	16 N.	8 E.			See Golden Center Gp.
Rocky Bar	33, 34	16 N.	8 E.			Reg. Mines; VIII, p. 433; XII, p. 200; XIII, p. 262
Rocky Glen	15, 16	18 N.	11 E.	Wm. Simkins, Trustee, Box 885, Nevada City	28	VIII, p. 450-451; XI, p. 310; XII, p. 200; M. M. R. Nev. Co., p. 242-243
Rogers	12	16 N.	8 E.	Claude Stark, Grant Bldg., Rm. 70, San Jose, et al.		See Mountaineer
Rolph Ranch (chrome)	28	15 N.	9 E.			M. M. R. Nev. Co., p. 78
Rose Hill	24	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley		Reg. Mines; XIII, p. 262-263; M. M. R. Nev. Co., p. 243-244
Rush & Minnie	27, 34	16 N.	8 E.			Reg. Mines
Russel Ravine	15, 16	18 N.	11 E.			See Rocky Glen
Sacramento						XX, p. 360
Saint (see St.)						
Sanders Ledge	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	8	See Sultana
San Jose	6	16 N.	9 E.	Thomas Lawrence, Rt. 1, Nevada City	7	
San Juan						See Boss
Santa Anita	30	18 N.	11 E.		20	See Spanish
Sauvee	35	16 N.	8 E.			Reg. Mines; XIII, p. 263
Scadden Flat	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley		See Massachusetts Hill
Schmidt Property (chrome)	21	15 N.	9 E.		6	M. M. R. Nev. Co., p. 79
Schofield	25	16 N.	8 E.	Idaho-Maryland Mines Co., Grass Valley	6	Reg. Mines
Schroeder						See Black Bear
Scotia (Good Hope)	27	16 N.	8 E.	Cooley Butler, Grass Valley		M. M. R. Nev. Co., p. 244
Sebastopol	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	17	Reg. Mines; XIII, p. 263; see Sultana
Seven Thirty		15 N.	8 E.			XI, p. 284; see Alcalde Mines
Shamrock	14	15 N.	8 E.	Mary Hanscom, 204 Sycamore St., Modesto, et al.	13	Reg. Mines; M. M. R. Nev. Co., p. 244
Sharpe Mng. Co.	17, 18, 20	16 N.	9 E.		120	M. M. R. Nev. Co., p. 244-245
Sharpe Quartz & Gravel Mng. Co.	32	17 N.	9 E.			M. M. R. Nev. Co., p. 246
Sierra Asbestos	2, 11	17 N.	10 E.			XVII, p. 434; M. M. R. Nev. Co., p. 67-70; XXVI, p. 91; see this report
Signal Gp.	21	16 N.	8 E.	Signal Gold Quartz Mng. Co., Mrs. E. M. Taylor, Agt., 140 Occidental Ave., Burlingame	25	
Silver Bar	34	16 N.	8 E.	Roman Catholic Bishop of Sacramento, Rev. J. O'Meara, Agt., 235 Chapel St., Grass Valley	8	
Sims Cons.	34, 35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	19	
Sirius						Reg. Mines; XIII, p. 263
Slate Ledge	10	15 N.	8 E.			Reg. Mines; XI, p. 277-278; XIII, p. 263-264; see Prudential
Sleeping Beauty	10	18 N.	10 E.	Sleeping Beauty Mng. Co., W. A. Muller, Agt., 731 Market St., San Francisco	15	Reg. Mines; XIII, p. 264

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TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Slide	35, 36	17 N.	7 E.	Mrs. Josie Dahlberg, Hammonton	42	
Slug Gp.	7	17 N.	11 E.	Washington Mng. & Dev. Co., 1968 Los Angeles Ave., Berkeley	18	
Smith, W. B. (garnet)	30	15 N.	8 E.			XXVI, p. 96
Sneath & Clay	11	16 N.	9 E.	C. C. Van Loben Sels, Vorden		Reg. Mines; M. M. R. Nev. Co., p. 234
Snowflake						M. M. R. Nev. Co., p. 246
Solace	27, 28	18 N.	11 E.	Gaston Gold Mines, Ltd., H. A. Moss, Agt., 82 Sutter St., San Francisco	16	
Somerset	23	16 N.	8 E.	Carl P. Jones, Grass Valley		
Sonntag Ranch (clay)	3	15 N.	9 E.			Bull. 99, p. 138, 313
South Banner	16, 21	16 N.	9 E.	Lava Cap Gold Mng. Corp., O. E. Schiffner, Agt., Nevada City	45	M. M. R. Nev. Co., p. 246
South Centennial, Lizard, Wasp & Summit	1	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	42	
South End						See Goodall Cons.
South Idaho Cons.	25, 26	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	26	XII, p. 200; XIII, p. 264; M. M. R. Nev. Co., p. 246-247
South Star Gp.	30, 31	16 N.	8 E.	South Star Gold Mines Co., 57 Post St., Rm. 407, San Francisco	60	M. M. R. Nev. Co., p. 247-248; XVII, p. 438; XVIII, p. 261; XXXI, p. 16
South Yuba	35, 36	17 N.	7 E.	See Red Ledge Cons.		M. M. R. Nev. Co., p. 248-249
Spanish	17, 18 19, 30 31	18 N.	11 E.	San Francisco Commercial Co., 1022 Crocker Bldg., San Francisco	180	Reg. Mines; VI, pt. 2, p. 51-52; VIII, p. 442-444; XII, p. 200; XIII, p. 264; M. M. R. Nev. Co., p. 249; XXVI, p. 53-54, 94-95, 128-129
Spanish	2	16 N.	8 E.	Carl P. Jones, Grass Valley		Reg. Mines; VIII, p. 149; XI, p. 292-293; XII, p. 200; XIII, p. 264; see Champion Gp.
Spanish (barytes)	19	18 N.	11 E.	San Francisco Commercial Co. (See above)		XXVI, p. 94-95; 53-54; see Spanish Mine
Spanish Hill	23, 26	16 N.	8 E.			Reg. Mines; VIII, p. 434
Spence Mineral Co. (copper)	25, 27	15 N.	6 E.			Bull. 50, p. 191-195; X, p. 392-393; XI, p. 313-314; M. M. R. Nev. Co., p. 90; XXVI, p. 195
Spion Kop Lode	11	15 N.	8 E.	P. J. Donovan, Grass Valley, et al.	12	
Spring Hill	23, 26	16 N.	8 E.	Lakenan Investment Co., Box 1001, Grass Valley	30	VIII, p. 434; XXXI, p. 16
Stacey	15, 16	18 N.	11 E.	Wm. Simkins, Trustee, Box 885, Nevada City	13	See Rocky Glen
Standard Gp.		15 N.	8 E.	Mattie Gold Mng. Co.		XXXI, p. 16; see Alcalde Mines
Standard		18 N.	10 E.	Leslie J. Hegarty, Nevada City, et al.		
Stanford (Oro Fino)	3	16 N.	8 E.	St. John Quartz Mng. Co., Grass Valley		Reg. Mines; XIII, p. 264-265
Star Ledge Gp.	34, 25	18 N.	11 E.	Star Mill & Mng. Co., H. Bennett, Agt., 6107 Laird Ave., Oakland	22	

Star Light	11	15 N.	8 E.	W. F. Hayes, Grass Valley	8	
Starr Gp.	9	17 N.	11 E.	Star Mng. Co., Estate of Geo. W. Starr, Grass Valley	42	M. M. R. Nev. Co., p. 249-250
Steele	11	15 N.	9 E.	Mrs. M. M. Steele, P. O. Box 326, Colfax	80	XXVI, p. 137
Steephollow Gp.	13, 14 23	16 N.	10 E.	Chas. W. Kitts, et al.	138	M. M. R. Nev. Co., p. 250
Stem Winder, Etna	12, 13 14	17 N.	11 E.	Eagle Bird Mines, Inc., Geo. G. Thomas, Bagdad Copper Corp., Hillsdale, Ariz.	60	See Eagle Bird Cons.
Stockton	9	14 N.	8 E.	W. F. Hayes, R.F.D. 1, Grass Valley	20	Reg. Mines
Stockton Hill	9	14 N.	8 E.	Stockton Hill Corp., 139 N. Virginia St., Reno, Nev., Walter R. Woock, Pres., 153 Aeolia Dr., Auburn (operating Stockton)		
St. Gothard Cons	21, 28	18 N.	9 E.	Louis Nonnemann, 575 Dewey Blvd., San Francisco	41	XI, p. 307; XII, p. 201; XIII, p. 265; Reg. Mines; see Delhi
St. Johns	10	16 N.	8 E.	M. A. Curry, 405 Fillmore St., Taft		
St. Johns	22	16 N.	8 E.	St. John Q. Mng. Co., Grass Valley	13	Reg. Mines; XI, p. 281-282; XII, p. 201; XIII, p. 265; XXVI, p. 137
St. Louis (Alpine & Little Done)	17	16 N.	9 E.	St. Louis Mine, Elizabeth C. Barker, Agt., Santa Maria del Oro, Durango, Mexico via Rosario	36	M. M. R. Nev. Co., p. 116; XIII, p. 235
St. Louis Cons.	9	16 N.	9 E.	St. Louis Cons. Gold Mines Co., J. T. Hennessey, Agt., Grass Valley	25	VIII, p. 451-452; XVII, p. 438; see Neversweat
Stockbridge						See North Star
St. Patrick Cons.	1	17 N.	10 E.	C. M. Cross, Agt., Box 1468, San Francisco, et al.	58	
St. Stephens	1	15 N.	8 E.	M. S. White, Grass Valley		See Original Ben Franklin
Stonewall Jackson	5, 6	15 N.	8 E.			See Alcalde Mines
Sultana	1 35, 36	15 N. 16 N.	8 E. 8 E.	Empire Star Mines Co., Ltd., Grass Valley	250	XI, p. 280; XII, p. 186; XIII, p. 238, 242, 258; M. M. R. Nev. Co., p. 250-252; XVII, p. 438; XVIII, p. 142-143; XX, p. 179
Summit Cons. Gold Mng. Co.	12, 13	16 N.	8 E.			XIII, p. 265; Reg. Mines; see Mountaineer
Sunlight Cons.	12, 13	17 N.	11 E.	Eagle Bird Mines, Inc., Geo. G. Thomas, Bagdad Copper Corp., Hillsdale, Ariz.	38	See Eagle Bird
Sunrise	1	15 N.	8 E.	Grass Valley Bullion Mines, F. W. McNear, Agt., Russ Bldg., San Francisco	11	See Alaska
Sunnyside & Bulah	26, 27 34, 35	18 N.	13 E.			See Tola Gp.
Sunset	12	17 N.	11 E.			See Blue Bell
Sunny South	27, 34	18 N.	13 E.			See Gray Eagle
Sweet Ranch	13 4	14 N. 14 N.	7 E. 8 E.			Bull. 50, p. 201; Bull. 99, p. 138-139; M. M. R. Nev. Co., p. 252-253, 79
Sylvanite Gp.	9	17 N.	13 E.	Julius Adolph, 1282 23d Ave., San Francisco	33	XX, p. 360
Syndicate Cons. Gp.	2	15 N.	8 E.	Wheeler Henderson, et al.	53	Reg. Mines; XIII, p. 265; M. M. R. Nev. Co., p. 253
Taylor	19	16 N.	9 E.	C. H. Taylor, Grass Valley	77	
Teddy	1, 15 8, 35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	3	See Sultana
Telegraph						XI, p. 282
Texas (New York)	8	16 N.	9 E.			Reg. Mines; M. M. R. Nev. Co., p. 253
Thomas	13	16 N.	8 E.	Nevada City Mng. Dev. Assn., E. M. Rector, Agt., Nevada City	8	

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* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
Thompson Ranch (chrome)	5	14 N.	8 E.		640	M. M. R. Nev. Co., p. 79
Thompson & Berry	2, 3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	21	
Three Johns		17 N.	13 E.			XX, p. 360
Three Sevens	11, 15	15 N.	8 E.			See Norambagua
Tilden, Judd & O'Keefe	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	13	
Tipperary	11, 14	16 N.	8 E.	Carl P. Jones, Grass Valley	1	
Tola Gp. (copper)	26, 27 34, 35	18 N.	13 E.	J. E. Anderson, Box 5, Auburn	61	Bull. 50, p. 201; M. M. R. Nev. Co., p. 90-91; XX, p. 360-361
Tracy	25	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	5	
Treasure Box	1 36 31	17 N. 18 N. 18 N.	10 E. 10 E. 11 E.	Frank Dillon, Nevada City		
Tribute	33	16 N.	8 E.			Reg. Mines
Tule Belle	28, 33	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley		
Tunnel Discovery	35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	16	
Turner Gp. (copper)	16	18 N.	13 E.		120	Bull. 50, p. 201; M. M. R. Nev. Co., p. 91
Turtledove (chrome)	1	17 N.	10 E.			Bull. 76, p. 159; M. M. R. Nev. Co., p. 79
Twin Sisters	12, 13	18 N.	10 E.	Twin Sisters Quartz Mng. Co., Chas. Hegarty, Agt., 1450 Clay St., San Francisco		Reg. Mines; XIII, p. 265; XX, p. 11; XXVI, p. 129-130 XXXII, p. 189-204
Union Nos. 1 & 2						
Union	16	16 N.	9 E.			VIII, p. 419; XIII, p. 266; M. M. R. Nev. Co., p. 254
Union Hill	25, 36	16 N.	8 E.	Idaho Maryland Mines Corp., Grass Valley	23	M. M. R. Nev. Co., p. 254-256, 263
Union Jack & Smuggler	1	15 N.	8 E.	Bullion Cons. Mng. Co., F. W. McNear, Agt., Russ Bldg., San Francisco		See Bullion Cons.
United Banner, United Eagle & Macon	2, 11	11 N.	11 E.	Katherine B. Ostrander, John R. Wilson, Agt., 1032 Mills Bldg., San Francisco		See Yuba Cons.
United Lode	9	16 N.	9 E.	E. J. N. Ott, Agt., Nevada City	17	
Ural	11	16 N.	8 E.	Carl P. Jones, Grass Valley	14	Reg. Mines; XXVI, p. 104; see Champion Gp.
Uranus	16, 17 20, 21	16 N.	8 E.	Marie Haub Kaehler, 1476 19th Ave., San Francisco		
U. S. Grant Lode	26	16 N.	8 E.	Marie Knight, 204 N. Auburn St., Grass Valley, et al.		See Kentuck
U. S. Grant	4, 9	17 N.	13 E.	Miss Evelyn D. Lewison, Agt., 1855 Washington St., Apt. 301, San Francisco	21	
Valentine Cons.	5 32	17 N. 18 N.	11 E. 11 E.	Bradley Mining Co., 1022 Crocker Bldg., San Francisco	40	M. M. R. Nev. Co., p. 256
Viola		17 N.	13 E.			Reg. Mines; XIII, p. 266

Vulcan Lode	5, 6	15 N.	8 E.		18	M. M. R. Nev. Co., p. 256
Waldeck	4	17 N.	11 E.		39	See Columbia Gp.
Wallington	2, 11	16 N.	8 E.	Carl P. Jones, Grass Valley	1	
Walworth	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley	14	
Waldeck (Washington)	4	17 N.	11 E.	Redstone Mines Corp.	39	See Columbia Gp.
Washington Chief Cons.	35, 36	18 N.	11 E.	J. P. Flint, Trustee, Martin Vanberg, Agt., Nevada City	41	M. M. R. Nev. Co., p. 257; see Arctic
Washington	19, 30	16 N.	9 E.	Mrs. Matilda Uphoff, 1367 Vallejo St., San Francisco, et al.	37	
Washington (German) Cons.	8, 9 11, 12 16, 17	17 N.	11 E.	Theo. J. Roche, Executor, 1108 Humboldt Bldg., San Francisco	110	Reg. Mines; VIII, p. 440-441; XII, p. 202; X, p. 391-392; XIII, p. 266; M. M. R. Nev. Co., p. 256-257
Washington Tunnel		17 N.	10 E.	E. P. McCulla, Agt., Washington		
Watt & Co.	34	16 N.	8 E.	Empire Star Mines Co., Ltd., Grass Valley	7	
West Delhi	20, 21 29	18 N.	9 E.	H. A. Curnow, Nevada City, et al.	60	Reg. Mines; XIII, p. 266; see Delhi
Western Merger	32	17 N.	9 E.			XXVI, p. 130
Western Copper Co.						XX, p. 12
West Point	31	16 N.	8 E.	R. L. Owens, c/o Harry W. Wernse, 933 Monadnock Bldg., San Francisco	20	Reg. Mines; M. M. R. Nev. Co., p. 257-258
Wetteran Ranch (copper)	34	15 N.	7 E.		540	Bull. 50, p. 201; M. M. R. Nev. Co., p. 91
Wheeling, West Virginia & Ohio	16, 17 20, 21	18 N.	11 E.		60	See Ancho & Erie
Whipple & Bartlett	9	16 N.	11 E.	C. P. Hanson, 1215 Grand St., Alameda		
White & Johnson	14	17 N.	10 E.	H. J. White, 1149 Howard St., San Francisco, et al.		
White Oak	3	15 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	15	Reg. Mines
White Wings						Reg. Mines; XIII, p. 266
Wild West						See Alpine
Wild Cat Cons.	33, 34	16 N.	8 E.	Empire Star Mines Co., Ltd., North Star Mine, Grass Valley	17	
William Penn						See Crown Point
William Tell Gp.	1	15 N.	8 E.	Mrs. Mary Roach, 1455 8th Ave., San Francisco	35	
Willow Valley	4	16 N.	9 E.			See Montana-Willow Valley Gp.
Winfield Scott	2	15 N.	8 E.			Reg. Mines; XI, p. 283; XII, p. 203; XIII, p. 267
Wisconsin Gold & Silver	10, 15	18 N.	11 E.	Fanny Milocek, 1505 West St., Oakland	22	See Birchville
Wisconsin & Illinois	2, 3	15 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	29	X, p. 375-376; XI, p. 284-285; XIII, p. 267; see Empire West
Woil (chrome)		16 N.	9 E.			Bull. 76, p. 158-159; M. M. R. Nev. Co., p. 79-80
Wolf (Limekiln) (chrome)	4	14 N.	8 E.			Bull. 76, p. 159; M. M. R. Nev. Co., p. 80
Woodberry	1	15 N.	8 E.	Woodberry Mng. Co., Josie Spargo, Agt., Grass Valley	4	See Osborne Hill
Woodville	16	16 N.	9 E.	No. Banner Cons. Tunnel Co., E. E. Simpson, Secy., Crocker Bldg., San Francisco	19	See No. Banner Cons.
Work Your Own Diggings						See W. Y. O. D.
Wotell						XXXII, p. 189-204
Wren Ranch (manganese)	20	14 N.	8 E.			Bull. 76, p. 51; M. M. R. Nev. Co., p. 262

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* To save space, frequently only one of several names is shown in this column.

TABLE OF QUARTZ MINES AND PROSPECTS, NEVADA COUNTY—Continued

Name of mine	Location			To whom assessed*	Area, acres	Bibliography
	Sec.	Twp.	Range			
W. Y. O. D.	34, 35	16 N.	8 E.	Empire Star Mines Co., Ltd., Empire Mine, Grass Valley	16	Reg. Mines; VIII, p. 435; X, p. 379-381; XI, p. 269-270; XIII, p. 267; XII, p. 203; see Pennsylvania
Wyoming	11, 12	16 N.	8 E.	Carl P. Jones, Grass Valley	18	Reg. Mines; VI, p. 48; XI, p. 291; XII, p. 203; XIII, p. 267; see Champion Gp.
Yellow Diamond	3	16 N.	8 E.	Otto E. Gruenwald	--------	Reg. Mines; XIII, p. 268
Yellow Metal Gp.	9	18 N.	12 E.	Lakemont Gold Mng. Co., R. J. Golding, Box 33, Venice	91	M. M. R. Nev. Co., p. 258
Yerba Buena	3	16 N.	9 E.	S. W. Marsh, Nevada City, et al.	163	XI, p. 304; M. M. R. Nev. Co., p. 259
Young America	11	15 N.	8 E.	William Crase, Le Duc St., Grass Valley	16	Reg. Mines
Young Mack & Old Mack Lode	17, 18	16 N.	9 E.	J. H. Rogers, et al., Bruce Wallace, Agt., Box 253, Nevada City	31	--
Yuba Cons.	11	17 N.	11 E.	Katherine B. Ostrander, John R. Wilson, Agt., 1032 Mills Bldg., San Francisco	17	M. M. R. Nev. Co., p. 259-260; 134, 151
Yuba Canyon Cons.	13	17 N.	11 E.	Eagle Bird Mines, Inc., Geo. G. Thomas, Bagdad Copper Corp., Hillsdale, Ariz.	41	See Eagle Bird
Zeibright	34	17 N.	11 E.	Empire Star Mines Co., Inc., Grass Valley	40	M. M. R. Nev. Co., p. 260-261

* To save space, frequently only one of several names is shown in this column.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

Geology of California and the Occurrence of Oil and Gas

A large volume has just been issued by the Division of Mines, representing Part Two of Bulletin 118, "Geologic Formations and Economic Development of the Oil and Gas Fields of California", prepared under the direction of the Geologic Branch.

This volume is of particularly large size (8½ by 11 inches), and its 200 pages, its 115 figures, and 5 tip-in plates contain a wealth of technical information of constant use to those persons interested in the oil and gas industry. Whereas Part One (already published) is concerned with the "Development of the Industry", Part Two outlines the geologic history of California, and shows the relationship of its geology to the occurrence of mineral deposits, particularly oil and gas. Detailed correlation of the various oil field formations is given, together with a discussion of the origin of the mineral fuels.

The following *Editorial Note,* quoted from Part Two, explains the purpose of the volume:

> "PART TWO represents the second of four divisions of Bulletin 118, and is intended, *first,* to outline the broader features of the geology of California and to indicate their significance and relationship to the mineral industry; *second,* to review the statigraphic and structural history of the State, more especially of the better-known parts of the coastal region; *third,* to present pertinent and well-established conceptions of the complicated stratigraphic correlation of the upper Mesozoic and Cenozoic sedimentary rocks involved in the exploration for oil and gas; and *fourth,* to discuss the processes of oil generation and accumulation. It is hoped that the many accompanying charts and maps, explicitly prepared for frequent reference, together with carefully chosen photographs of characteristic fossils, may materially assist geologists in future exploration not only for new deposits of oil and gas, but for all manner of valuable mineral resources. A better understanding of the extremely complex history and structure of the sedimentary rocks of California is in itself an accomplishment of lasting importance to the whole scientific, engineering, and industrial world. Since Part Two is an assemblage of articles written by individual authors, it should not be expected that all interpretations will be found in perfect harmony. The variety in point of view should lend flavor to the reading of factual details."

Following is an outline of contents of Part Two, Bulletin 118, which is now available as a "Pre-Print", and may be secured, together with Pre-Print Part One, by subscription to all four parts of the bulletin.

Chapter IV

Introduction to the Geology

Geomorphic Provinces of California, by Olaf P. Jenkins

Salient Geologic Events in California and Their Relationship to Mineral Deposition, by Olaf P. Jenkins

Position of the California Oil Fields as Related to Geologic Structure, by Ralph D. Reed

Chapter V

Geologic History and Structure

California's Record in the Geologic History of the World, by Ralph D. Reed

Geologic History and Structure of the Central Coast Ranges of California, by N. L. Taliaferro

Chapter VI

Paleontology and Stratigraphy

Characteristic Fossils of California, by G. Dallas Hanna and Leo George Hertlein

Descriptions of Foraminifera, by C. C. Church

Synopsis of the Later Mesozoic in California, by Frank M. Anderson

Notes on California Tertiary Correlation, by Bruce L. Clark

Eocene Foraminifera Correlations in California, by Boris Laiming

Sequence of Oligocene Formations of California, by Lesh C. Forrest

Correlation Chart of the Miocene of California, by Robert M. Kleinpell; Introduction by William D. Kleinpell

Pliocene Correlation Chart, by U. S. Grant IV and Leo George Hertlein

The Pleistocene in California, by J. E. Eaton

Chapter VII

Occurrence of Oil

Stratigraphic Formations of the Producing Zones of the Los Angeles Basin Oil Fields, by Stanley G. Wissler

Correlation of the Oil Fields of the Santa Maria District, by Stanley G. Wissler and Frank E. Dreyer

Correlation of Oil Field Formations on East Side San Joaquin Valley, by Glenn C. Ferguson

Correlation of Oil Field Formations on West Side of San Joaquin Valley, by Paul P. Goudkoff

Origin, Migration, and Accumulation of Oil in California, by Harold W. Hoots

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

HISTORY OF THE NAMES COBALT AND NICKEL

By W. B. Winston[a]

The name Cobalt has an interesting history. It comes from Kobalt, also written Kobolt, Kobelt, Kobold, Kobel in German folklore and signifying a house-spirit (Hausgeist), and also an underground or mine-spirit (Grubengeist). It dates from the early Middle Ages and the name was in general use towards the end of the fifteenth century. Some authorities have it that the house-spirit may have come from the mine Kobold, cave or earth-spirit. He was said to be originally a God.

According to Meyers Lex. and the Gr. Herder, the name Kobold is perhaps derived from the old German root Kob (preserved in Koben) and Walt (Walten) meaning *der im Hause Waltende* or the one who rules the house. Also, (signifying Kobewalt i.e. Hauswalter) or Housekeeper. Denoting the most benevolent as well as the evil house-spirit.

The Kobold was dwarf-like, little and as a rule ugly. The house Kobalt, or Hausgeist, was sometimes harmless and a bringer of prosperity to the house which he inhabited. He was sometimes malicious, punished disorderly work, and was always known as a sort of hobgoblin. Kobolds were also thought to be spirits of the dead, or fallen angels, demons and will-of-the-wisps.

The mine Kobalt or Grubengeist, usually known as Kobold, was mostly an evil spirit. He was incessantly working to cause rocks to fall, preferably on the miners, to bring about caves and slides, and make timbers break, etc. All strange underground noises were attributed to him. Knockings were particularly considered due to Kobold activities. Strange lights and glimmers, particularly when in worthless rock, were the doings of Kobolds, as well as the impoverishing of ores of an appearance rich in silver, but which upon smelting yielded no returns. Such ores were said to have been bewitched by the Kobolds, and the silver made to disappear. The Kobold also had the faculty of making himself, as well as things, invisible.

In the mining language of the Middle Ages, Kobalt signified ore in appearance like silver ore, or copper ore, such as Kupernickel or Copper-Nickel (Niccolite), often associated with Cobalt and in appearance like Copper, but upon smelting gave no such metal, hence were considered bewitched by the Silver or Nickel Kobolds. The term Kobalt was therefore a name of derision for worthless material of good appearance and it had become firmly established for over two hundred years before the discovery of the metals Cobalt and Nickel in 1733 and 1751 respectively.

Agricola, in his writings, mentions the Kobold or Kobelt at length and various authorities describe him, briefly as follows:

Meyers Lex. "The name Kobalt was already in use towards the end of the 15th century and springs, no doubt, from Kobold, (Grubengeist) mine-spirit, as the miners looked upon all ores which upon smelting gave no metal, as the product of an evil mine or cave-spirit (Berggeist). Later one understood under Kobalt, minerals which gave a blue color to glass. The metal Kobalt was discovered by G. Brandt in 1733."

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[a] Mining Engineer, San Francisco, California.

Brookhaus. v. Heckscher des German. Kulturkreises. Tl. 1. 1925. "Kobold [der des Köbens (i.e. des Gemaches)—Waltende] or he who rules the hut or house, an earth and house-spirit (Erd und Hausgeist) in German folklore. Originally God of the hearth (Gottheit des Herdfeuers). A dwarfish, ugly little being, sometimes harmless and a bringer of prosperity to the house, sometimes malicious and punishes slovenly work. But he always bears the mark of a hobgoblin. In many places the Kobold is known as a spirit of the dead or as demons and will-of-the-wisps."

"Kobalt of equal meaning with the name Kobold, was a term in the mining language of the Middle Ages, (the same as Nickel), for ores with an external appearance of copper and silver ores which upon smelting gave none of the expected metal, thus were considered bewitched by the mine Kobolds (Berg Kobolde)."

Deutsches Worterbuch. Kobalt . . . Paracelsusschriften, Basel 1589, 8, 350. "G. Brandt is credited with the discovery of the metal in 1733." (A. Menge). The name of the ore, of this formerly worthless material, was retained.

. . . "The name as well as the ore have a peculiar history behind it. Whereas the Kobalt ores are now considered very valuable, the name given to it by the miners of the Middle Ages was originally one of derision. According to Adelung, the miners call everything Kobalt which upon smelting does not give any metal, which gives off odor of sulphur and arsenic and robs other metals or makes them brittle." . . .

. . . *Hubner's Zeitungslex.* 1722, 2, 1009. "Kobold, a poisonous, robbing worthless ore, which impoverishes the valuable ores or makes them wild and cold, by which many believe that it consumes the silver, thence it received the name from the miners." . . .

. . . After Knunitz, 42, 7. "The miner even calls everything he does not know, Kobalt or Kobolt, and the metallurgist can not be more derogatory, when he curses some poor ore which often has a rich appearance, than to call it Kobalt. Kobolt and Kobalt is namely a term originally given to the ore by the miners from the spectre like mine-spirit who robs the silver and causes poor ore, as well as foul and poisonous air and other calamities. The name was already firmly established when some of the virtues of the formerly hated ore became known in the Erz Mountains in Saxony in the 17th century. In the same manner has Nickel, which is usually found in company with Kobalt, received its name from the Nickel Kobold." . . .

. . . "The term Kobalt, which originated in the Hartz and in the Erz Mountains came into general use. It is called in Swedish Kobolt, in Danish and Nederlandish Kobalt, in French Cobolt and Cobalt, in English Cobalt, in Italian and in Spanish Cobalto, and in Latin Cobaltum."

Agricola, De Re Metallica 1550. English translation by Herbert Hoover, page 217. ''In some of our mines, however, though in very few, there are other pernicious pests. These are demons of ferocious aspect, about which I have spoken in my book De Animantibus Subterraneis.''

''This and other evils is the reason why many mines are not being worked any more.'' (N. Ger. Trns., p. 187)

New German translation, published by the Agricola-Society of the German Museum, page 540. ''Finally one may count among the animals living underground and which often dwell in the mines those known by theologians as spirits. There are two kinds, i.e. the ones known as 'daemon Subterraneous truculentus', mine-devils, and the 'Bergmänlein' or little miner, Kobold or Gutte. The first named are of a wild and fear-inspiring aspect and most unfriendly and hostile disposed towards the miners. Thus there was one of these at Annaberg who killed more than twelve workmen with his breath in the Rosenkranz mine. The breath flowed from his mouth. He is said to have had a long neck like that of a horse and wild eyes. Of the same kind was one wearing a black cowl at Schneeberg, who lifted the tools from the floor of one level and deposited them, not without bodily effort, on a higher level in this mine once rich in silver. Pfellus, who distinguishes between six kinds of spirits says, that this one is the worst kind, that he is enclosed in a stronger cover than the others. Many philosophers consider these and similar spirits who are injurious and by nature malicious as stupid and without reason.''

English translation by Herbert Hoover page 217. ''Then there are the gentle kind which the Germans as well as the Greeks call cobalos because they mimic men. They appear to laugh with glee and pretend to do much, but really do nothing. They are called little miners, because of their dwarfish stature, which is about two feet. They are venerable looking and are clothed like miners in a filleted garment with a leather apron about the loins. This kind does not trouble the miners, but they idle about in shafts and tunnels and really do nothing, although they pretend to be busy in all kinds of labour, sometimes digging ore, sometimes putting into buckets that which has been dug. Sometimes they throw pebbles at the workmen, but rarely injure them unless the workmen first ridicule or curse them. They are not very dissimilar to goblins.'' Elsewhere mention is made of the ''Knockers''.

NICKEL

In 1751, the Swedish mineralogist v. Cronstadt discovered Nickel. He also gave the shorter name Nickel, already in use centuries before to the ore known as Kupfernickel or Copper-Nickel (Nickeline, Niccolite) in 1754. The name Nickel given to Kupfernickel by the miners of the Middle Ages is also derived from the same teasing demons as Kobalt. The word in German meaning among other, to tease, to lead on, to betray, etc. For Kupfernickel having the appearance of copper, upon smelting, gave no such metal.

This term also came into international use. It is called in German, English, French, Nickel, in Spanish, Niquel, in Hollandish, Magyar Nikkel, in Italian Nichel.

ALUMINUM

By George L. Gary, Mineral Technologist

Properties

The principal commercial ore of aluminum is bauxite, a mixture of hydrous aluminum oxides of indefinite composition. Some bauxites approach closely the composition of *gibbsite,* $Al(OH)_3$, but most are a mixture, and usually contain iron. As a result, bauxite has been discredited as a mineral species and in a rigid classification should be used only as a rock name, but the name has been retained here since it has become so firmly fixed as the name of the important commercial substance. The principal constituents of the rock bauxite are *gibbsite,* $Al(OH)_3$, *boehmite,* $Al(OH)_3$, and *diaspore,* $AlO(OH)$, any one of which may be dominant. *Cliachite,* $Al(OH)_3$, is the name proposed for the very fine-grained amorphous constituent of bauxite. *Cryolite,* Na_3AlF_6, imported from Greenland, has been used as an ore of aluminum and also as a flux in the electrolytic process by which most of the metal is obtained. Aluminum is the most abundant of the metals, for it is an essential constituent of most of the rock-forming silicates and of clays derived from their alteration. However, the enormous amounts of aluminum contained in the various silicates are not yet available because of the difficulty and expense of extraction, and only the rock, bauxite, a mixture of hydrous aluminum oxides, is at present an important ore. Bauxite is found in pisolitic, or round concretionary grains; also massive, earthy and clay-like. The luster is dull to earthy. The color and streak is white, gray, yellow and red. The hardness is 1–3; the gravity 2–2.55.

Occurrence

Bauxite is of secondary origin, commonly produced under subtropical to tropical climatic conditions by the prolonged weathering of aluminum bearing rocks. It also may be derived from the weathering of clay-bearing limestones. It has apparently originated as a colloidal precipitate. It may occur in place as a direct derivative of the original rock, or it may have been transported and deposited in a sedimentary formation. In the tropics deposits known as *laterites,* consisting largely of hydrous aluminum and ferric oxides, are found in the residual soils. These vary widely in composition and purity but may become valuable as sources of aluminum and iron. Bauxite occurs over a large area in the south of France, an important district being at Baux (originally Beaux), from which locality it derived its name. Large quantities are produced in Dutch Guiana and British Guiana and shipped to the United States. In the United States the chief deposits are found in Georgia, Alabama, and Arkansas where bauxite was formed by the alteration of a nepheline-syenite. Pisolitic bauxite has been found in one locality in Riverside County, California, and diaspore occurs in compact masses with andalusite in one locality in Mono County, California. Transparent crystals of diaspore in chlorite schist have been found by the writer in one locality in Calaveras County, California.

Preparation

The usual process at present by which aluminum is extracted from the bauxite ores is briefly as follows: The ore is heated to low redness with sodium carbonate, forming sodium aluminate. This compound is leached out by water, and by passing Co_2 gas into the solution the aluminum is precipitated as the hydroxide. On being heated the hydroxide is converted into the oxide of the metal. The pure metal is prepared from this oxide by an electrolytic process which takes place in a bath of fused cryolite, or an artificial sodium-aluminum fluoride. The tank in which the reaction takes place is lined with carbon and forms the cathode, graphite rods suspended in the bath serving as the anode. The metal collects in the bottom of the tank. About 4 tons of bauxite are needed to make 2 tons of the oxide, which in turn makes about 1 ton of aluminum.

Uses

Because of its great strength and low density, aluminum has been adapted to many uses. Sheets, tubes, and castings of aluminum are used wherever a light-weight metal is desired, as in the manufacture of automobiles, airplanes, railway cars, and machinery. It is used extensively in cooking utensils and household appliances and furniture. Aluminum is a good electrical conductor and to some extent is replacing copper in power transmission lines. Numerous aluminum alloys are in common use. *Duraluminum,* 96 percent aluminum, 3 percent copper, and 1 percent magnesium, is the trade name of the most important. It has only one-third the weight of steel and yet possesses most of its desirable properties. *Aluminum bronze* contains 10 percent aluminum, 90 percent copper. Aluminum is also alloyed with zinc, nickel, silicon, silver and tin. Other uses of aluminum are in paint, aluminum foil, and as a constituent of numerous salts.

Tests

Infusible aluminum minerals, when moistened with cobalt nitrate and intensely heated before the blowpipe, assume a blue color. The mineral should be powdered and heated either on charcoal or on the loop of a platinum wire. Ammonia, when added in excess to an acid solution containing aluminum precipitates aluminum hydroxide. The precipitate is flocculent and colorless or white. It is precipitated under the same conditions as ferric hydroxide and since the latter has a dark color a small amount of aluminum hydroxide might be overlooked in a mixture of the two. To make a further test under these conditions, filter off the precipitate and treat it with a hot solution of sodium hydroxide, which will dissolve any aluminum hydroxide present but will not affect the ferric hydroxide. Filter, to the filtrate add hydrochloric acid in slight excess, and then make alkaline with ammonia hydroxide again. This will precipitate as pure aluminum hydroxide any aluminum that may be present.

Markets

Aluminum per lb., delivered, commercial and mill ingot, 99 plus percent, 17¢. Bauxite per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 percent Al_2O_3, 1.5 to 2.5 percent Fe_2O_3, $7.00 @

$8.00, f.o.b. Alabama and Arkansas mines. Other grades 56 to 59 percent Al_2O_3, 5 to 8 percent SiO_2, $7.00 @ $8.00, f.o.b. Arkansas mines. Pulverized and dried, 56 to 59 percent Al_2O_3, 8 to 12 per cent SiO_2, $14.00 @ $16.00, f.o.b. Arkansas mines; abrasive grade, crushed and calcined, 80 to 84 per cent Al_2O_3, $14.00, f.o.b. Arkansas mines. Crude (not dried) 50 to 52 percent, $4.00, f.o.b. Arkansas mines. (Quotations, May 1, 1941.)

Possible Buyers

Aluminum Ore Co., subsidiary of Aluminum Co. of America, Gulf Building, Pittsburgh, Pa.
American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York, N. Y.
E. I. du Pont de Nemours & Co., Incorporated, 1007 Market St., Wilmington, Del.
General Chemical Co., 40 Rector St., New York, N. Y.
Gulf Oil Corporation, Gulf Bldg., Pittsburg, Pa.
Hercules Powder Co., Wilmington, Del.
Mineral Products Corporation, Marysvale, Utah.
National Aluminate Corporation, 6216 W. 66th Pl., Chicago, Ill.
Stauffer Chemical Co., 624 California St., San Francisco, Calif.
The Carborundum Co., Niagara Falls, N. Y.

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Herbert A. Franke and M. E. Trought. Bauxite and Aluminum. Minerals Yearbook, 1940. U. S. Bur. of Mines, pp. 637–658.

E. C. Harder. Bauxite. Industrial Minerals and Rocks, 1937. The American Institute of Mining and Metallurgical Engineers, pp. 111–128.

C. L. Mantell. Aluminum and Bauxite. The Mineral Industry During 1939. McGraw-Hill Book Co., New York and London, 1940, pp. 7–27.

Adolf Pabst. Minerals of California. Calif. State Div. of Mines. Bulletin No. 113 (1938).

G. A. Roush. Strategic Mineral Supplies. McGraw-Hill Book Co., New York and London, 1939, pp. 200–237.

Notes

1. Specimens of aluminum ores may be seen in the museum of the California State Division of Mines, Ferry Building, San Francisco, California.

2. Alunite, a basic potassium aluminum sulfate, $KAl_3(OH)_6(SO_4)_2$, is used in the production of alum. Recently at Marysvale, Utah, alunite has been mined and treated in such a way as to recover aluminum from the mineral.

QUARTZ

By George L. Gary, Mineral Technologist

Properties

Quartz, silica, or silicon dioxide, SiO_2, occurs in many different forms; as crystals commonly prismatic, with prism faces horizontally striated, also in massive forms of great variety. From coarse to fine-grained crystalline to flintlike or cryptocrystalline, giving rise to many variety names. It also may form in concretionary masses; as sand. Fracture conchoidal or shell-like. Luster vitreous, in some specimens greasy, splendent. Transparent to translucent. Possesses strong piezoelectric and pyroelectric properties. Streak and color usually colorless or white, but frequently colored by various impurities and may then be any color. The hardness is 7; the gravity 2.65.

The more important varieties with a brief description of each, follow:

Coarsely Crystalline Varieties

1. *Rock Crystal.* Colorless quartz, commonly in distinct crystals.

2. *Amethyst.* Quartz colored purple or violet, often in crystals.

3. *Rose Quartz.* Coarsely crystalline, but without crystal form, color a rose-red or pink. Often fades somewhat on exposure to light.

4. *Smoky Quartz; Cairngorm Stone.* Frequently in crystals of a smoky yellow to brown and almost black color. Named cairngorm from the locality of Cairngorm in Scotland.

5. *Citrine.* Light yellow in color.

6. *Milky Quartz.* Milky white in color owing to minute liquid inclusions. In some cases with greasy luster.

7. *Cat's-eye.* A stone which, when cut in a round shape (*en cabochon*), exhibits an opalescent or chatoyant effect, as it is termed, is called a cat's-eye. Quartz among other minerals, gives at times this effect, which is due either to fibrous inclusions or to the fibrous nature of the quartz itself. The latter is seen in *tiger's-eye,* a yellow fibrous quartz from South Africa, which is pseudomorphic after the fibrous mineral crocidolite.

8. *With Inclusions.* Many other minerals occur as inclusions in quartz and thus give rise to variety names. *Rutilated quartz* has fine needles of rutile penetrating it. Tourmaline and other minerals are found in quartz in the same way. *Aventurine* is quartz including brilliant scales of hematite or mica. Liquids and gases may occur as inclusions; both liquid and gaseous carbon dioxide exist in some quartz.

Cryptocrystalline Varieties

The cryptocrystalline varieties of quartz may be divided into two general classes; namely, *fibrous* and *granular,* which in most cases, are impossible to tell apart without microscopic aid.

A. Fibrous Varieties.

Chalcedony is the general name applied to those varieties having a fibrous alignment of particles, visible however only under the microscope. It is more specifically thought of as a brown translucent variety, with a waxy luster, often mammillary and in other imitative shapes. Chalcedony has been deposited from aqueous solutions and is frequently found lining or filling cavities in rocks. Color and banding give rise to the following varieties:

1. *Carnelian.* A red chalcedony.

2. *Chrysoprase.* An apple-green chalcedony.

3. *Heliotrope* or *bloodstone.* A green chalcedony with small red spots in it.

4. *Agate.* A variegated variety with alternating layers of chalcedony and opal, or granular cryptocrystalline quartz. The different colors are usually in delicate, fine parallel bands which are commonly curved, in some specimens concentric. Most agate used for commercial purposes is colored by artificial means. Some agates have the different colors not arranged in bands but irregularly distributed. *Moss agate* is a variety in which the variation in color is due to visible impurities, often manganese oxide in moss-like patterns. Wood that has been petrified by replacement by clouded agate is known as *silicified* or *agatized wood.*

5. *Onyx.* Like agate, is a layered chalcedony and opal, with layers arranged in parallel planes.

B. Granular Varieties.

1. *Flint.* Something like chalcedony in appearance, but dull, often dark in color. It usually occurs in nodules in chalk and breaks with a prominent conchoidal fracture giving sharp edges. Used for various implements by early man.

2. *Chert.* A compact massive rock similar in most properties to flint, but usually light in color.

3. *Jasper.* A granular cryptocrystalline quartz, usually colored red from hematite inclusions.

4. *Prase.* Dull green in color; otherwise similar to jasper, and occurs with it.

Occurrence

Quartz occurs as an important constituent of those igneous rocks which have an excess of silica, such as granite, rhyolite, pegmatite. It is extremely resistant to both mechanical and chemical attack, and thus the breakdown of igneous rocks containing it yields quartz grains which may accumulate and form the sedimentary rock sandstone. Also occurs in metamorphic rocks, as gneisses and schists, while it forms practically the only mineral of quartzites. Deposited often from solution and is the most common vein and gangue mineral. Forms as flint deposited with chalk on the sea floor in nodular masses. Solutions carrying silica may replace beds of limestone with a granular cryptocrystalline quartz known as *chert,* or discontinuous beds of chert may form contemporaneously with the limestone. In rocks it is associated chiefly with feldspar and muscovite; in veins with practically the entire range of vein minerals. Often carries gold and becomes an important ore of that metal. Occurs in large amount as sand in stream beds and upon the seashore and as a constituent of soils. Many forms of silica are produced in commercial amounts in California as sand, quartz, quartzite, sandstone and chalcedony. Fine large specimens of rock crystals, smoky quartz, rose quartz and a small amount of amethyst have been found in California as well as other varieties of quartz mentioned herein.

Preparation

Methods of mining the various siliceous materials vary widely, dependent on the form of the material, nature and location of deposits, and type of product to be made. However, most of the deposits are worked by open-pit or quarrying methods, often in a very crude way. Sand deposits may be worked by hydraulicking, by dredging or by the use of a steam shovel. Vein quartz is often obtained as a by-product in the mining of other materials. Pegmatite quartz is almost always obtained as a by-product in working pegmatite dikes for feldspar or mica. In the grinding and preparation of silica for market several methods are in use, dependent upon the type of raw material, the character of the product desired, and the progressiveness of the producer. For ceramic use silica is ordinarily ground to pass through a 140 mesh sieve, but for paint, polishes, fillers, etc., much finer grinding is necessary, a 200 or even 300 mesh product being required. For sand paper much coarser grains are needed and these grains must be carefully graded by size. Massive flint and crystalline quartz are very hard and tough. Crushing the crude rock is difficult and expensive, and to obviate this it is often calcined before crushing. Calcination is usually done in a small vertical kiln, resembling a lime kiln, fired with wood or coal, in which is placed alternate layers of rock and fuel. As the fuel burns away the charge slowly sinks in the kiln, the heated rock being removed at the bottom and quenched with water. The calcined rock may then be broken down by hand, and fed to ''chaser mills'' or crushed in jaw crushers, possibly followed by chaser mills. Fine grinding may be done either wet or dry. Wet grinding may be accomplished in conical mills, short tube mills, in long tube mills or in wet grinding pans. If a wet grinding process is used the finished product is usually sized by some system of water classification. Dry grinding may be done in conical mills, short pebble mills of the intermittent type or long tube mills. In dry grinding methods sizing of the finished product is not common, but in some instances air separation may be used. The wet ground product may be dried by steam in open tanks or over steam-pipe racks or in rotary driers.

Uses

Quartz is widely used in its various colored forms as ornamental material. As sand used in mortar, in cement, as a flux, as an abrasive, and in the manufacture of glass and silica brick. In powdered form is used in porcelain, paints, sandpaper, and scouring soaps, and as a wood filler. As quartzite, sandstone, and in its various other rock forms as a building stone and for paving purposes. Large amounts of quartz sand are used as an acid flux in certain smelting operations.

As rock crystal in various optical and electrical equipment. Its military use is in radio transmitting and receiving sets for controlling the output frequency of the radio transmitters and the response frequency of the radio receivers and in frequency meters.

Tests

Infusible even on the thinnest edges. When fused with an equal volume of sodium carbonate, effervesces and gives a colorless glass; unacted upon by salt of phosphorus. Soluble only in hydrofluoric acid.

Markets

Quartz Rock Crystals—For fusing, all sizes, $100 @ $150 per ton. Prisms for piezo-electrical and optical use command premium. Silica—Per ton, water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $21 @ $40 for 92 to 99½ percent grades. Dry-ground, aid-floated, 325 mesh, 92 @ 99½ percent silica, $18 @ $30. Glass sand, f.o.b. producing plant, $1.25 @ $5 per ton; molding sand, 50¢ @ $3.50; blast sand, $1.75 @ $6. California: $5 for quartz and $2.50 for sand. (Quotations May 1, 1941.)

Possible Buyers

Silica

Charles B. Chrystal Co., Inc., 11 Park Pl., New York, N. Y.
The Dicalite Company, 120 Wall St., New York, N. Y.
Stanley Doggett, Inc., 75 Varick St., New York, N. Y.
Industrial Minerals & Chemical Co., 6th & Gilman St., Berkeley, Calif.
Innis Speiden & Co., Inc., 117 Liberty St., New York, N. Y.
Johns-Manville Corp., 22 E. 40th St., New York, N. Y.
Kennedy Minerals Co., 2550 E. Olympic Blvd., Los Angeles, Calif.
L. A. Salomon Bro., 216 Pearl St., New York, N. Y.
Smith Chemical & Color Co., 55 John St., Brooklyn, N. Y.
Tamms Silica Co., 228 N. La Salle St., Chicago, Ill.
United Clay Mines Corp., Prospect and Oakland St., Trenton, N. J.
Western Talc Co., 1901 E. Slauson Ave., Los Angeles, Calif.
Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York, N. Y.
C. K. Williams & Co., 640 N. 13th St., Easton, Pa.
Wishnick-Tumpeer, Inc., 295 Madison Ave., New York, N. Y.

Quartz Crystals

Bausch & Lomb, Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
U. S. Navy Department, Federal Office Bldg., Civic Center, San Francisco, Calif.

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V. L. Eardley-Wilmot. Abrasives. Industrial Minerals and Rocks. The American Institute of Mining and Metallurgical Engineers. New York (1937) pp. 1–58.

Herbert Hughes. Granules. Industrial Minerals and Rocks. The American Institute of Mining and Metallurgical Engineers. New York (1937) pp. 347–352.

Robert W. Metcalf. Abrasive Materials. Minerals Yearbook (1940). U. S. Bur. of Mines. pp. 1271–1286.

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H. Ries. Special Sands. Industrial Minerals and Rocks. The American Institute of Mining and Metallurgical Engineers. New York (1937) pp. 749–762.

R. M. Santmyers. Quartz and Silica. U. S. Bur. of Mines. Inf. Circ. 6472, 6473, 6474 (1931).

J. R. Thoenen. Sand & Gravel. Industrial Minerals and Rocks. The American Institute of Mining and Metallurgical Engineers. pp. 671–720.

Paul M. Tyler. Quartz. Industrial Minerals and Rocks. The American Institute of Mining and Metallurgical Engineers. New York (1937) p. 517.

Notes

1. Specimens of quartz may be seen in the museum of the California State Division of Mines, Ferry Building, San Francisco, California.

2. Silica sand suitable for glass manufacturing would no doubt be of interest to the following glass companies:

Brock Glass Co., 202 Santa Fe St., Santa Ana, Calif.
Chrysolite Products Corp., 1708 Standard Ave., Glendale, Calif.
A. H. Fostar Co., 2414 E. 58th St., Los Angeles, Calif.
Technical Glass Co., 2050 E. 48th St., Los Angeles, Calif.
Hazel-Atlas Glass Co., 89th and G St., Oakland, Calif.
Lathford Marble Glass Co., 7441 Roseberry Ave., Huntington Park, Calif.
Glass Products, Inc., 2435 E. 56th St., Los Angeles, Calif.
Glass Containers Corp., 36th and Santa Fe., Los Angeles, Calif.
Maywood Glass Co., 5615 S. Riverside Dr., Los Angeles, Calif.
Mississippi Glass Co., Fullerton, Calif.
Owens-Illinois Pacific Coast Co., 1855 Folsom St., San Francisco, Calif.
Philadelphia Quartz Co., Quartz and Independent St., South Gate, Calif.
Los Angeles Chemical Co., 1960 Santa Fe., Los Angeles, Calif.

NEW MINING LAWS

An act to amend Section 2313 of the Public Resources Code, relating to mining claims, tunnel locations and mill sites, and the recording of notice of location, markings of boundaries, and performance of discovery work.

The people of the State of California do enact as follows:

Section 1. Section 2313 of the Public Resources Code is hereby amended to read as follows:

2313. Within 90 days after the posting of his notice of location upon a lode mining claim, placer claim, tunnel right or location, or mill site claim or location, the locator shall record a true copy of the notice together with a statement of the markings of the boundaries as required in this chapter, and of the performance of the required discovery work, in the office of the county recorder of the county in which such claim is situated. The county recorder shall receive a fee of one dollar ($1) for this service.

This new law becomes effective on September 13, 1941.

An act for the protection of the domestic water supplies of cities, towns or districts from pollution by placer mining operations, providing a method of recording information with respect to operators using such methods, and providing penalties for the violation of this act.

The people of the State of California do enact as follows:

Section 1. Any person, firm or corporation, other than placer mine operators who hold permits from the California Debris Commission to operate, who has been engaged or who shall engage in the operation of a placer mine on any stream or on the watershed of any stream tributary directly or indirectly to the Sacramento or San Joaquin rivers shall record in the office of the county recorder of the county in which its mine is situate, within 60 days from and after the effective date of this act, or, if operations are commenced after the effective date, then within 30 days after the commencement of such operations, a verified statement verified by the operator or by some one in behalf of the operator, showing:

(1) A description of the ground proposed to be mined by placer mining methods, described by United States Government subdivisions where possible.

(2) The names and addresses of the owners of the ground.

(3) The names and addresses of the operators of the mine.

(4) The proposed means or method of placer mining operation.

(5) The means which the operator proposes to use to prevent the pollution of any stream by the effluent from such operations.

In the event an owner or operator changes his address, or of a transfer of ownership or change of operator of any such mining property, then within 10 days after any such transfer or change, a notice setting forth the names and addresses of the new owners or operators shall be filed in the office of the county recorder.

Sec. 2. No placer mining operator who does not hold a permit to operate from the California Debris Commission shall mine by placer process on any stream or on the watershed of any stream tributary directly or indirectly to the Sacramento or San Joaquin rivers without taking the following precautions to prevent pollution of the stream by the effluent from operations:

(1) Constructing a settling pond or ponds of sufficient size to permit the clarification of water used in the mining processes before the water is discharged into the stream.

(2) Mixing with the effluent from mining operations aluminum sulphate and lime, or an equivalent clarifying substance which will cause the solid material in the effluent to coagulate and thus avoid rendering the water in the stream unfit for domestic water supply purposes.

(3) Notwithstanding the provisions of Subdivision 2 of this section, any placer miner who is operating by dredging process and who desires to transport his dredger across a stream where the expense of constructing settling ponds in the stream itself would, in the opinion of the operator, be unduly heavy, shall have the right to conduct the dredger across the stream without constructing a settling pond under the following procedure: The operator shall give to the clerk or secretary, as the case may be, of each city or district owning or operating a domestic water supply the clarity of which is likely to be affected by the crossing operation, notice of the intent of the operator to cross the stream. Such notice shall be given at least seven days in advance of the date that the operator expects to cross the stream with his dredger. Upon the expiration of the notice the operator may during the following 48 hours conduct his dredger across the stream even though some turbidity may be caused by the crossing operation. Having crossed the stream the operator shall thereupon and thereafter in its further operations observe the provisions of Subdivision 2 of this section.

Sec. 3. Any person, firm or corporation who fails to record the notice provided for in Section 1, or to install the protective devices or to give the notice provided for in Section 2, or both, shall be guilty of a misdemeanor. The operation of any placer mine on ground not covered by a permit to the operator from the California Debris Commission, without compliance with the provisions of both Sections 1 and 2 hereof, is hereby declared to be a public nuisance which may be enjoined upon suit brought by the district attorney of the county in which the operation has been conducted, or by any city or district whose domestic water supply is rendered unfit or dangerous for human consumption by the acts, or failure to act, of the operator. The superior court of the county in which the operation is conducted shall have jurisdiction to hear and determine the action and to award such relief as may be proper therein. Nothing in this act contained, however, shall be deemed or construed to deprive the State, any city, city and county, county, district, person, firm or corporation of any right to bring and maintain any action or proceeding, in any jurisdiction, which it was entitled to bring or maintain prior to the enactment of this act, or to receive or obtain in any such action any remedy accorded to it under existing law.

SEC. 4. If any section, subsection, sentence, clause or phrase of this act is for any reason held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this act. The Legislature hereby declares that it would have passed this act and each section, subsection, sentence, clause and phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses or phrases be declared unconstitutional.

An act to add Section 2326 to the Public Resources Code, relating to the records of dissolved mining districts.

The people of the State of California do enact as follows:

SECTION 1. Section 2326 is hereby added to the Public Resources Code, to read as follows:

2326. Whenever any mining district in this State, organized or created under the laws of the United States, is dissolved, the officers or custodians of the records of the mining district shall deposit with the county recorder of the county, in which the district is located, all records of location notices or other documents affecting titles to mining claims in the mining district, shown by the records of the district.

County recorders of the several counties of the State of California shall accept any location notices and other documents affecting title to mining claims of dissolved mining districts. Thereafter all such notices and documents shall be open for public inspection.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

Kenneth I. Fulton has been appointed Director of the Department of Natural Resources vice Richard Sachse who has been appointed by His Excellency Governor Olson to be a member of the State Railroad Commission. Mr. Fulton is a graduate in ceramic engineering of Ohio State University, with graduate work in mining and metallurgy at University of California, and has served as secretary to Governor Olson.

Clarence A. Logan, district mining engineer in the Sacramento office of the Division of Mines, has been ''loaned'' to the State Lands Commission under a contract with that agency to examine and classify lands owned by the State of California as to their mineral possibilities and values. The Commission has under its jurisdiction more than a million acres of state ''school lands'' (Sections 16 and 36 in each township). Any of these lands having mineral deposits can not be sold, but may be leased.

Charles V. Averill, district mining engineer has been transferred from the Redding office to the Sacramento office.

J. C. O'Brien, junior mining engineer and librarian in the San Francisco headquarters has been promoted to the grade of assistant mining engineer and assigned to duty in the Redding district office.

Fenelon F. Davis has been appointed a geological draftsman on the staff of the San Francisco headquarters office. He is a graduate of the University of California in petroleum engineering and geology.

New Publications

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, January, 1941, being Chapter 1 of State Mineralogist's Report XXXVII. This chapter contains: "Mineral Resources of Trinity County," including a map of the county showing the principal mineral deposits; "Strategic Minerals Procurement"; "Geologic Investigations of the Chromite Deposits of California"; and special articles on "United States Supreme Court Renders Far-reaching Decision on Power Permits on 'Navigable' Streams"; and "Securities and Exchange Commission."

COMMERCIAL MINERAL NOTES (Nos. 217, 218, 219) May, June, July, 1941 respectively. These 'Notes' contain the lists of 'mineral deposits wanted' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to five pages in recent months.

Mail and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco Office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum

HENRY H. SYMONS, Statistician and Curator

Tabulations are presented herein showing the complete totals for all substances produced in California during the year 1940, grouped by substances and by counties. The complete detailed annual report on the mineral production of California for 1940 will be available later as Bulletin 121 of the State Division of Mines.

SUMMARY—1940

The total value of the mineral output of California for the year 1940 was $342,825,817, being a decrease of $9,636,747 from the total of 1939 which was $352,462,564, the decrease being due to petroleum. There were sixty-two different mineral substances, exclusive of a segregation of various stones grouped under gems; and all fifty-eight counties of the State contributed to the list.

As revealed by the following, salient features of 1940 as compared with the previous year were: All groups of mineral substances, such as metals, structural materials, industrial minerals and salines showed an increase in total value, with the exception of the fuels which showed a decreased value. Of the year's mineral output quicksilver showed the greatest increase in value followed in turn by cement, miscellaneous stone, tungsten ore, gold, copper, magnesite, soda, mineral water, etc.; while decreases in amount and value were shown by petroleum, natural gas, brick and hollow building tile, and potash. The greatest annual value for their output in California was recorded by lime, limestone, molybdenum ore, gypsum, silica (glass sand), soda, and sulphur.

Of the fuels, petroleum showed a decrease in value of $20,879,056 and a decrease in amount from 224,253,110 barrels to 223,294,805 barrels of crude oil. In the early part of the year there was a cut in prices paid for all grades of crude, in most fields. Natural gas showed an increase in amount used but a decrease in total value from 340,754,804 M. cubic feet worth $21,551,646 to 352,871,945 M. cubic feet worth $20,618,893.

Of the metals all materials under this group showed an increase in amount and value with the exception of chromite, iron ore, and silver. The highest value of output since 1856 being recorded for gold, for quicksilver since 1876, for tungsten since 1918, and all times for molybdenum. The gold production increased from 1,435,264 fine ounces to 1,455,671 fine ounces in amount and in value from $50,234,240 to $50,948,485. Quicksilver increased from 11,201 flasks worth $1,102,563 to 18,907 flasks worth $3,209,754; tungsten from 74,110 units worth $1,153,735 to 107,022 units valued at $2,267,135, copper from 8,390,215 pounds worth $872,582 to 12,833,363 pounds worth $1,450,170; with increased values recorded by molybdenum ore, lead, platinum group metals, zinc, antimony, and manganese. The quicksilver miner received in 1940 the highest average annual price per flask ever paid in this state, which was $167.77.

Of the structural materials, cement increased in amount and value from 10,984,033 barrels worth $15,616,219 to 13,955,255 barrels valued at $17,673,202; lime from 87,288 tons worth $849,122 to 101,395 tons valued at $902,322; miscellaneous stone increased in value from $10,316,787 to $12,181,564; and the group increasing in total from $30,373,840 to $34,739,419.

The industrial group showed an increased total value from $5,622,449 to $6,388,748, with bentonite, pottery clay, diatomite, dolomite, gypsum, limestone, mineral water, silica (quartz and glass sand), and sulphur showing increased total values for the year. The total value of the saline group $13,178,499 to $13,674,519, with borates, bromine, iodine, magnesium salts, salt, and soda registering increases in total value for the year and potash the only one of this group showing a decrease in total value.

Distribution of the 1940 output of California by substances is shown on the following tabulation:

Substance	*Amount*		*Value*	*Number of Properties*
Antimony	56,845	lbs.	$7,958	17
Bentonite	10,360	tons	174,002	8
Borates	212,358	tons	5,254,154	5
Brick and hollow building tile	--------		2,762,885	42
Carbon dioxide	97,660	M. cu. ft.	23,877	3
Cement	13,955,255	bbls.	17,673,202	11
Chromite	2,599	tons	32,796	7
Clay (pottery)	324,399	tons	687,871	45
Copper	12,833,363	lbs.	1,450,170	(e)
Dolomite	18,178	tons	52,167	3
Feldspar	3,022	tons	16,644	3
Gems	--------		3,176	5
Gold	1,455,671	fine ozs.	50,948,485	(a)
Granite	--------		198,896	16
Gypsum	314,834	tons	599,944	9
Lead	3,092,636	lbs.	154,632	(e)
Lime	101,395	tons	902,322	25
Limestone	563,999	tons	895,832	
Magnesium salts	4,325	tons	419,666	3
Manganese ore	314	tons	3,260	4
Marble (f)	--------		15,189	5
Mineral water	16,190,549	gals.	960,701	38
Natural gas	352,871,945	M. cu. ft.	20,618,893	(b)
Petroleum	223,294,805	bbls.	207,479,800	
Platinum metals	1,358	fine ozs.	62,419	(e)
Pumice and volcanic ash	35,162	tons	126,516	16
Quicksilver	18,907	flasks	3,209,754	101
Salt	462,282	tons	1,290,728	16
Silica (quartz and glass sand)	101,041	tons	376,723	6
Sandstone	--------		13,083	9
Silver	2,359,776	fine ozs.	1,678,063	(e)
Slate	4,777	tons	18,031	3
Soapstone and talc	37,433	tons	329,425	11
Soda	228,108	tons	2,339,639	4
Stone, miscellaneous (c)	23,184,186	tons	12,181,564	356
Sulphur	8,156	tons	105,619	3
Strontium	627	tons	8,686	4
Tungsten ore	107,022	units WO_3	2,267,135	10
Zinc	182,088	lbs.	11,472	(e)
Unapportioned (d)	--------		7,470,438	
Total value			$342,825,817	

(a) There were 1,030 lode mines and 826 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

(b) There was an average of 15,199 producing wells.

(c) Includes macadam, crushed rock, ballast, rubble, rip rap, sand and gravel.

(d) Includes barite (2), bituminous rock (2), bromine (3), calcium chloride (1), calcium silicate (1), coal (2), diatomite (5), iodine (2), iron ore (3), lithia (1), magnesite (3), molybdenum ore (1), potash (1), pyrite (1), sillimanite group (1), titanium (1), zircon (1), mica (1), tube-mill pebbles (1), paving blocks (2).

(e) Included with gold.

(f) Includes onyx and travertine.

Distribution by counties for 1940 is given in the following tabulation:

County	*Value*	*Number of Mineral Products*
Alameda	$3,697,648	8
Alpine	18,211	4
Amador	4,284,886	10
Butte	2,722,816	10
Calaveras	4,233,835	10
Colusa	45,337	5
Contra Costa	1,960,631	10
Del Norte	24,689	5
El Dorado	2,094,405	11
Fresno	22,103,968	15
Glenn	16,891	1
Humboldt	133,590	6
Imperial	461,180	14
Inyo	2,855,646	20
Kern	62,855,732	19
Kings	13,649,445	4
Lake	884,427	4
Lassen	14,869	5
Los Angeles	98,183,754	21
Madera	110,074	7
Marin	151,800	3
Mariposa	1,224,336	7
Mendocino	109,110	4
Merced	2,514,323	6
Modoc	93,042	7
Mono	666,280	9
Monterey	307,177	10
Napa	829,589	10
Nevada	11,351,165	8
Orange	17,575,147	14
Placer	$2,023,484	14
Plumas	2,743,608	7
Riverside	3,918,747	16
Sacramento	5,928,834	10
San Benito	1,401,496	5
San Bernardino	15,772,742	31
San Diego	845,207	16
San Francisco	52,205	4
San Joaquin	1,146,912	7
San Luis Obispo	491,329	10
San Mateo	2,620,611	7
Santa Barbara	8,045,351	13
Santa Clara	3,229,052	10
Santa Cruz	2,779,306	9
Shasta	2,799,796	10
Sierra	969,323	4
Siskiyou	2,219,203	8
Solano	709,435	5
Sonoma	432,760	5
Stanislaus	1,558,205	8
Sutter	94,054	2
Tehama	51,880	1
Trinity	1,772,327	8
Tulare	220,065	8
Tuolumne	1,032,567	11
Ventura	20,647,881	8
Yolo	109,820	3
Yuba	4,035,614	5
Totals	$342,825,817	

LABORATORY

George L. Gary, Mineral Technologist

Since 1866 many lists have been published showing localities of California minerals. The last one, "Minerals of California," by Adolph Pabst, was published in 1938 by the Division of Mines as Bulletin No. 113.

It is the intention of the Division of Mines to publish in the quarterly new localities for minerals that are received by the laboratory for determination. So that this information may be accurate, it is requested that all specimens submitted for classification be accompanied by a letter giving the exact location where the material was found.

Corrections will also be noted as well as additions when called to our attention.

CORRECTIONS AND ADDITIONS TO BULLETIN 113

107. **Gersdorffite,** NiAsS, has been reported as occurring with **garnierite** $(Ni,Mg)SiO_3.nH_2O$ in the Pine Tree mine, in Sec. 9, T. 4 S., R. 17 E., M.D.M., Mariposa County.

108. **Millerite,** a nickel sulfide, and **pentlandite,** a sulfide of iron and nickel, occur with **pyrrhotite** (nickeliferous in part) and **chalcopyrite** in dike rock at the Ventura mine about 3 miles northeast of Triunfo in T. 1 N., R. 18 W., S.B.M.

109. **Torbernite,** a hydrous phosphate of uranium and copper, $Cu(UO_2)_2P_2O_8.12H_2O$ should be added to the index of Bulletin No. 113 as it is noted on page 218 as occurring with **autunite** in the northeastern part of San Bernardino County.

110. High-grade **scheelite,** a calcium tungstate, occurs with **quartz, epidote** and **garnet** at the Garnet Hill mine, just above the confluence of Moore Creek and the North Fork of the Mokelumne River, Calaveras County.

111. **Apatite,** a green calcium chloro- and fluo-phosphate, has been reported from Mariposa County.

LIBRARY

Henry G. Hubbard, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of Federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE SPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National:

U. S. Geological Survey:

Bulletin 922 J Chromite Deposits in the Seiad Quadrangle, Siskiyou Co.
922 L Quicksilver Deposits of the Mayacmas and Sulphur Bank Districts, Napa, Lake and Sonoma counties.
922 O Chromite Deposits of the Pilliken Area, El Dorado Co.
922 Q Tungsten Deposits in the Tungsten Hills, Inyo Co.
922 R Quicksilver Deposits in San Luis Obispo County and Southwestern Monterey County.
922 S Tungsten Deposits of the Benton Range, Mono County.
931 B Some Quicksilver Prospects in Adjacent Parts of Nevada, California and Oregon.

U. S. Bureau of Mines

Report of Investigations:

3545 Matte Smelting of Manganese.
3549 Measuring Particle-Size Distribution and Colloid Content of Oil-Well Drilling Fluids.

3550 Cooperative Fuel Research Motor-Gasoline Survey.
3551 Beehive and Byproduct Coking in Washington State.
3554 Survey of Fuel Consumption at Refineries (Oil).
3569 Ore-Testing Studies (Precious Metals).

Information Circulars:
7139 Grinding Pebbles and Tube-Mill Liners.
7144 Some Information on Quarry Safety.
7150 Some Information on the Causes and Prevention of Fires and Explosions in the Petroleum Industry.
7151 Some Preliminary Data on Methods for Controlling the Dust Hazards in Mechanical Mining.
7161 Petroleum Refineries, Including Cracking Plants in the United States.
7172 Developments in Petroleum Refining Technology.

Governmental, State

Alabama Geological Survey, University.
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries, Portland.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.

Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia, Geological Survey, Perth.

Societies and Educational Institutions

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences, of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers, New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Books

The Engineering Index—1940.
The Minerals Yearbook for 1941. (Review of 1940). U. S. Bureau of Mines.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Conservationist, Sacramento, California.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining World, Seattle.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Cheney, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.

Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Courier Free Press, Redding, California.
Daily Commercial News, San Francisco, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Humboldt Beacon, Humboldt.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mining Press, Reno, Nevada.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Owens Valley Progress-Citizen, Lone Pine, California.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
Randsburg Times, Randsburg, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PUBLICATIONS OF THE DIVISION OF MINES

During the past sixty-one years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

Write for latest revised price list.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price (including postage and sales tax)
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks Price $0.75, sales tax $0.02	$0.77
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr. Price $0.75, sales tax $0.02	.77
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr. Price $1.50, sales tax $0.05	1.55
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, XIV Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper Price $0.75, sales tax $0.02	.77
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----
Chapters of the State Mineralogist's Report, XV Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper Price $0.75, sales tax $0.02	.77

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price (including postage and sales tax)
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper Price $0.75, sales tax $0.02	$0.77
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper Price $0.75, sales tax $0.02	.77
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper Price $1.00, sales tax $0.03	1.03
Mines and Mineral Resources of Plumas County, 188 pp., paper Price $0.75, sales tax $0.02	.77
Mines and Mineral Resources of Sierra County, 144 pp., paper Price $0.75, sales tax $0.02	.77
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth Price $2.50, sales tax $0.08	2.58
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, **March, **April, May, June, July, August, September, October, November, December, 1922 Price $0.40, sales tax $0.01	.41
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 Price $0.40, sales tax $0.01	.41
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy Price $0.40, sales tax $0.01	.41
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties Price $0.40, sales tax $0.01	.41
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties Price $0.40, sales tax $0.01	.41
**July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	----
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties Price $0.40, sales tax $0.01	.41
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties Price $0.40, sales tax $0.01	.41
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price (including postage and sales tax)
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island Price $0.40, sales tax $0.01	$0.41
April, 1927, Mines and Mineral Resources of Amador and Solano Counties Price $0.40, sales tax $0.01	.41
**July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	--
October, 1927, Mines and Mineral Resources of Mono County Price $0.40, sales tax $0.01	.41
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County Price $0.40, sales tax $0.01	.41
April, 1928, Mines and Mineral Resources of Mariposa County Price $0.40, sales tax $0.01	.41
**July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	----
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties Price $0.40, sales tax $0.01	.41
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
**January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	----
**April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	----
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties Price $0.40, sales tax $0.01	.41
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties Price $0.40, sales tax $0.01	.41
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
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Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed) Free, postage $0.05	.05
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Samples (limited to two at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
KENNETH I. FULTON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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OF
MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
STATE MINERALOGIST'S REPORT XXXVII

STATE DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
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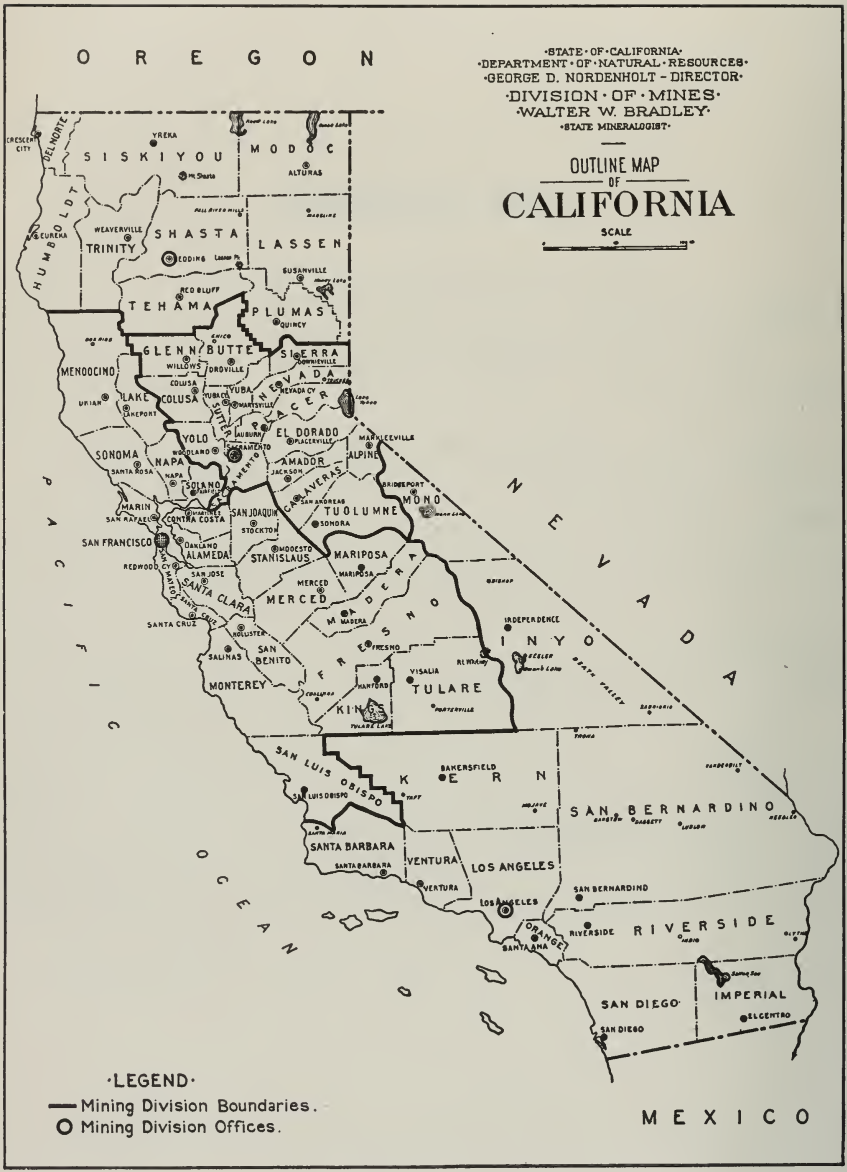
TABLE OF CONTENTS

Page
REPORTS OF DISTRICT MINING ENGINEERS 497
  Redding Field District 499
    Mineral Resources of Humboldt County 499
GEOLOGIC BRANCH 529
  Current Notes 529
  Tin in California, by Richard J. Segerstrom 531
  California Quicksilver Program of the Federal Geological Survey, by Edwin B. Eckel 558
SPECIAL ARTICLES 564
  Recent Developments in the Tungsten Resources of California 565
  New Manganese and Chrome Ore Specifications and Prices 589
  Does Scheelite Always Fluoresce? 593
  Bentonite 594
ADMINISTRATIVE 597
MINERALS AND STATISTICS 598
  Statistics 598
  Museum 599
LABORATORY 602
LIBRARY 603
PRODUCERS AND CONSUMERS 608
EMPLOYMENT SERVICE 608
PUBLICATIONS 609
INDEX TO VOLUME XXXVII 627



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OUTLINE MAP OF CALIFORNIA
SCALE
OREGON
NEVADA
MEXICO
PACIFIC OCEAN
DEL NORTE
CRESCENT CITY
SISKIYOU
YREKA
Mt. Shasta
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
GLENN
WILLOWS
BUTTE
OROVILLE
CHICO
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CALAVERAS
SAN ANDREAS
MARIN
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MARTINEZ
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STOCKTON
TUOLUMNE
SONORA
MONO
BRIDGEPORT
SAN FRANCISCO
OAKLAND
ALAMEDA
STANISLAUS
MODESTO
MARIPOSA
REDWOOD CY
SAN MATEO
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SAN BENITO
SALINAS
MONTEREY
FRESNO
INYO
INDEPENDENCE
DEATH VALLEY
Mt. Whitney
VISALIA
TULARE
HANFORD
KINGS
TULARE LAKE
SAN LUIS OBISPO
KERN
BAKERSFIELD
TAFT
MOJAVE
SAN BERNARDINO
SANTA MARIA
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
SANTA ANA
RIVERSIDE
SAN DIEGO
IMPERIAL
ELCENTRO
Salton Sea
·LEGEND·
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given county or area (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire state of a given mineral substance, e.g., feldspar).

3. Geological reports on specific areas (recording results and conclusions with maps, derived from field studies; and tied in with economic possibilities and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

REDDING FIELD DISTRICT

MINERAL RESOURCES OF HUMBOLDT COUNTY

By CHAS. V. AVERILL, Mining Engineer

HISTORY.

The region now known as Humboldt County was first visited by the white man when Spanish explorers landed from a ship and named Trinidad on Trinity Sunday, 1775. Humboldt originally was part of Trinity County but was separated in 1853, and was extended to the north in 1875. Trinidad was a thriving supply center for gold mines on the Klamath and Salmon Rivers in 1850-51. Humboldt Bay was visited late in 1849 by a party of miners from Trinity River, and early in 1850 by a ship from San Francisco, which was searching for a navigable stream to reach the mines. The captain of the ship gave the bay its present name. Pioneers established settlements at both Arcata and Eureka in 1850.

GEOGRAPHY.

Humboldt is one of the north Pacific Coast counties, and only the small County of Del Norte lies between it and the State of Oregon. The area is 3634 square miles. Population of Humboldt County is about 45,000, and of Eureka, the county seat, about 17,000 persons. The length from north to south is 100 miles, with width one-third as great. The greater part of the county is rugged and mountainous. Roughly parallel spurs of the Coast Range trend northwestward through the central, western and southern parts, which are drained by the Mattole, Bear, Eel, and Mad rivers. These rivers rise either within the county or at short distances to the south and east. The northern and northeastern parts of the county contain spurs of the Klamath Mountains, and are drained by Redwood Creek and the Trinity and Klamath rivers. Orleans Mountain reaches an altitude of 6184 feet.

CLIMATE.

The climate is moist and cool near the coast, and the temperature-difference between summer and winter is not great. Average seasonal temperatures at Eureka are 55° Fahrenheit in summer and 47° in winter. The highest temperature of record at Eureka is 85°. Farther inland, humidity is lower, summer temperature may reach 100°, and several feet of snow may fall in winter.

TRANSPORTATION.

The Redwood Highway, a State highway from San Francisco to Portland, Oregon, passes through the redwood forests of Humboldt County. Branching State highways wind through the mountains to the east to reach Klamath River, Red Bluff, Weaverville, and Redding. Northwestern Pacific Railroad runs trains from San Francisco Bay to Eureka, a distance of 284 miles. Humboldt Bay accommodates ocean-going vessels with a draft of 20 feet.

INDUSTRIES.

The beautiful redwood forests of Humboldt County furnish not only its main scenic attraction, but also its main industry. Forests of these tall trees (maximum height, 364 ft.) to the extent of thousands of acres are being preserved by means of State parks. The Bull Creek-Dyerville park area alone includes 13,000 acres; and the Redwood Highway runs through smaller parks for many miles.

The cutting of redwood timber and its manufacture into lumber normally give employment to about 5000 men, who annually receive more than $6,000,000 in pay. Very large lumber mills are located at Scotia, Samoa, Korbel, and Eureka. The lumber is highly resistant to insect and fungus attacks, and is of high quality for sills, outside frames, siding, shingles, pipes, and greenhouses. Persons who have extracted gold from ore with cyanide solution are familiar with its high quality for tanks. Lumber is produced from Douglas fir, cedar, and sugar pine also, but in smaller amounts. Many of the cut-over areas are being replanted with redwoods. One of the lumber companies has published the following figures as an example of the yield of a single, very large redwood tree:

Total height	308 ft.
Diameter, 5 ft. above ground:	
With bark	20 ft. 0 inches
Without bark	18 ft. 2 inches

	Diameter		Feet board measure
	Feet	Inches	
1st log	17	10	34,347
2d log	17	6	33,075
3d log	17	2	31,827
4th log	16	10	30,603
5th log	16	6	29,403
6th log	16	2	28,227
7th log	15	10	27,075
8th log	15	4	25,392
9th log	14	10	23,763
10th log	14	4	22,188
11th log	13	10	20,667
12th log	13	4	19,200
13th log	13	2	18,724
14th log	12	6	16,875
Total feet board measure merchantable timber			361,366

Figures are based on Spaulding standard scale with allowance for loss in falling, and 22 inches for bark. The tree will yield sufficient lumber to completely build 22 average homes.

Dairying is second in importance as an industry. Dairy cows to the number of 30,000 supply nine large plants for the manufacture of butterfat products and cheese. They are at Arcata, Loleta, Ferndale, Fernbridge, Grizzly Bluff, Alton, Cape Town, and Orick.

Farming is extremely diversified. Moist climate and good soil combine to produce an abundance of feed; and sheep, cattle, hogs, and goats are raised in large numbers. Poultry-raising has been introduced more recently and is increasing. Many varieties of grains, fruits, berries, and vegetables are produced. Farms numbering 2363 have an acreage of 816,451 and an annual output valued at $8,000,000. The Eureka Woolen Mills consumes annually 1,500,000 pounds of grease wool. Commercial fisheries along the Humboldt coast yield 5,000,000 pounds of food-fish annually. The mineral industry is described in detail below.

GEOLOGY.

Details of much of the geology of Humboldt County have not yet been mapped; hence only a general idea of the geology can be presented. About two-thirds of the county to the southeast is occupied by Franciscan sediments of probable Jurassic age. Near the coast, large areas of Pliocene sediments overlie the Franciscan formations, and minor areas of Miocene and Cretaceous sediments are known. In the northern part of the county are ancient schists of possible pre-Cambrian age overlain by Paleozoic sedimentary formations. In the northeast corner, both basic and acidic igneous rocks have been intruded. Thin strata of Quaternary sands, gravels, and clays may overlie any of the formations mentioned. They are abundant near Humboldt Bay.

MINERAL RESOURCES.

Gold is the chief metal mined, and miscellaneous stone the most important nonmetallic. Each of these has been produced to the value of millions of dollars since 1880, when the compilation of county records by the State Division of Mines was begun. Much gold was taken out in the preceding 30 years also, of which no public record segregated by counties is available. The county contains known resources of black sands, coal, copper, clay, gem materials, iron, limestone, manganese, mineral water, natural gas, petroleum, platinum, silver, miscellaneous stone, sand, and gravel. Prospects of barite, graphite, magnesite, quicksilver, and talc have been found.

An alphabetical list of these minerals containing details of their occurrence follows. Value of annual production since 1880 is given in the accompanying table.

MINERAL PRODUCTION OF

Year	Gold, value	Silver, value	Mineral water		Brick	
			Gallons	Value	M	Value
1880	$153,940	$80	------	------	------	------
1881	75,000	300	------	------	------	------
1882	100,000	------	------	------	------	------
1883	80,000	------	------	------	------	------
1884	115,000	------	------	------	------	------
1885	29,730	------	------	------	------	------
1886	83,591	------	------	------	------	------
1887	111,532	------	------	------	------	------
1888	100,000	------	------	------	------	------
1889	143,701	274	------	------	------	------
1890	93,612	82	------	------	------	------
1891	99,329	19	------	------	------	------
1892	87,515	------	------	------	------	------
1893	66,354	------	------	------	------	------
1894	41,326	14	20,000	$7,200	------	------
1895	92,635	------	24,000	12,000	------	------
1896	65,093	------	15,000	10,000	------	------
1897	94,992	57	10,000	2,000	------	------
1898	57,512	------	------	------	300	$2,500
1899	65,059	------	6,000	1,500	410	3,870
1900	109,444	[1]136	6,000	2,000	795	7,100
1901	98,487	[1]59	7,825	2,000	1,005	7,810
1902	60,015	------	10,000	2,500	2,170	17,040
1903	38,509	------	------	------	1,060	10,445
1904	62,061	------	------	------	2,565	21,350
1905	45,824	------	------	------	800	7,600
1906	48,295	240	------	------	915	8,690
1907	40,109	214	------	------	140	1,400
1908	33,066	325	------	------	760	8,585
1909	25,690	94	------	------	1,310	9,750
1910	35,289	150	------	------	476	4,048
1911	34,966	169	------	------	357	2,880
1912	31,271	150	------	------	772	6,415
1913	25,611	132	------	------	500	4,150
1914	18,686	57	------	------	607	6,120
1915	15,947	62	2,000	500	463	5,565
1916	21,279	55	3,000	750	(2)	------
1917	23,086	95	(2)	------	(2)	------
1918	8,028	72	(2)	------	(2)	------
1919	16,260	134	(2)	------	(2)	------
1920	2,538	19	------	------	(2)	------
1921	2,054	37	------	------	------	------
1922	1,330	10	(2)	------	(2)	------
1923	2,260	12	(2)	------	(2)	------
1924	1,269	7	(2)	------	(2)	------
1925	13,142	62	------	------	------	------
1926	1,243	6	------	------	------	------
1927	1,729	14	------	------	------	------
1928	1,788	7	------	------	(2)	------
1929	2,372	101	------	------	(2)	------
1930	2,255	9	------	------	(2)	------
1931	2,678	5	------	------	(2)	------
1932	2,549	4	------	------	(2)	------
1933	5,902	11	------	------	------	------
1934	28,978	80	------	------	(2)	------
1935	31,677	70	------	------	------	------
1936	36,155	118	------	------	------	------
1937	27,230	94	------	------	------	------
1938	20,825	58	------	------	------	------
1939	45,955	113	------	------	------	------
Totals	$2,781,773	$3,807	[2]$103,825	$40,450	[2]15,405	$135,318

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[1] Recalculated to 'commercial' from 'coining value' as originally published.

[2] See under 'Unapportioned.'

[3]Includes crushed rock, rubble, rip-rap, sand, gravel.

HUMBOLDT COUNTY, 1880-1939

Miscellaneous stone[3], value	Natural gas		Miscellaneous and unapportioned		
	M cu. ft.	Value	Amount	Value	Substance
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
$199,240	---	---	---	---	
251,586	---	---	---	---	
233,454	---	---	---	---	
193,502	---	---	---	---	
297,276	---	---	---	---	
160,845	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	---	
---	---	---	---	$362	Platinum.
---	---	---	---	140	Platinum.
---	---	---	12.5 ozs.	204	Platinum.
---	---	---	30.8 ozs.	555	Platinum.
---	---	---	---	---	
13,074	---	---	1,280 cu. ft.	1,280	Granite.
29,170	600	$300	2,450 tons	7,640	Clay.
			---	20,985	Unapportioned, 1900-1909.
36,700	1,000	500	250 tons	750	Clay.
37,756	300	150	937 tons	937	Clay.
229,730	300	150	396 tons	400	Clay.
439,808	300	150	7,750 lbs.	1,201	Copper.
208,204	300	150	3 ozs.	115	Platinum.
335,292	(2)	---	---	1,320	Copper and natural gas.
60,260	(2)	---	7 ozs.	296	Platinum.
			---	192,255	Brick, clay, granite, natural gas.
27,014	(2)	---	6 ozs.	351	Platinum.
			---	9,312	Brick, clay, mineral water, natural gas, volcanic ash.
51,082	640	85	370 tons	21,744	Chromite.
			210 tons	420	Clay.
			---	116	Granite.
			1,520 tons	57,751	Manganese.
			2 ozs.	140	Platinum.
			---	2,516	Brick, mineral water, pumice.
25,198	(2)	---	---	9,271	Brick and clay.
			---	1,148	Mineral water and natural gas.
133,290	(2)	---	859 tons	18,513	Manganese.
			---	5,436	Brick, clay, granite, mineral water, natural gas, volcanic ash.
131,688	(2)	---	75 tons	190	Pottery clay.
			---	4,628	Brick, mineral water, natural gas, platinum, pumice.
117,308	(2)	---	---	6,399	Brick and clay.
			---	153	Mineral water and natural gas.
			4 fine ozs.	413	Platinum.
422,519	(2)	---	---	9,915	Clay and clay products, mineral water, natural gas, platinum.
476,449	(2)	---	---	7,753	Brick, clay, mineral water, natural gas, platinum.
699,740	---	---	---	6,207	Brick, pottery clay, mineral water, natural gas, platinum.
700,736	---	---	---	4,052	Brick and clay.
			---	633	Natural gas and platinum.
554,963	---	---	---	6,096	Includes brick, clay, natural gas and platinum.
291,491	(2)	---	---	6,941	Brick, natural gas.
270,422	(2)	---	64,553 lbs.	11,361	Copper.
			---	9,422	Brick, clay, natural gas.
263,025	(2)	---	---	5,344	Brick, clay, natural gas, platinum.
194,324	(2)	---	---	2,979	Brick, clay, natural gas, platinum.
112,877	(2)	---	---	2,045	Brick, clay, natural gas, platinum.
65,012	(2)	---	---	126	Copper, natural gas.
50,371	(2)	---	---	2,003	Brick, clay (pottery), natural gas.
50,707	---	---	---	2,611	Brick, clay, natural gas.
37,829	---	---	---	3,996	Brick, clay, natural gas, gold, silver.
70,596	---	---	---	2,795	Brick, clay, natural gas, platinum.
73,705	---	---	---	2,593	Brick, clay, natural gas, platinum.
81,556	---	---	---	5,526	Brick, clay, natural gas, platinum.
$7,627,699	[2]3,440	$1,485	---	$459,224	

BARITE.

Liscom Hill Deposit. Near the summit of Liscom hill, eight miles northeast of Arcata, and not far from Blue Lake, a number of veins of white crystalline barite have been noted. The veins range from a few inches to one foot in width, and the dip is nearly vertical. Boulders of barite in the vicinity indicate that development work may uncover a deposit of commercial size.

Bibl: State Mineralogist's Report XXI, p. 300.

BLACK SAND.

From time to time the beaches of northern Humboldt County have been worked for gold, and a little platinum has been recovered. Years ago, at least one operation of this kind proved profitable. This was at Lower Gold Bluffs, probably near Sec. 17, T. 11 N., R. 1 E., H. M. The success of the operation was dependent on what was known as a 'panning-sea.' Waves of a certain size and kind excavated natural riffles in the sand of the beach, and gold concentrated in these. After the tide had receded, pack-mules were taken to the beach, and the sand was packed in sacks. The gold was very finely divided and was recovered by means of the Oregon tom, ordinary tom, and amalgamating plates. Many thousands of dollars worth of gold were produced in this way; but the gold is no longer concentrated to the same extent. Perhaps the off-shore deposit that was feeding the beach has been exhausted.

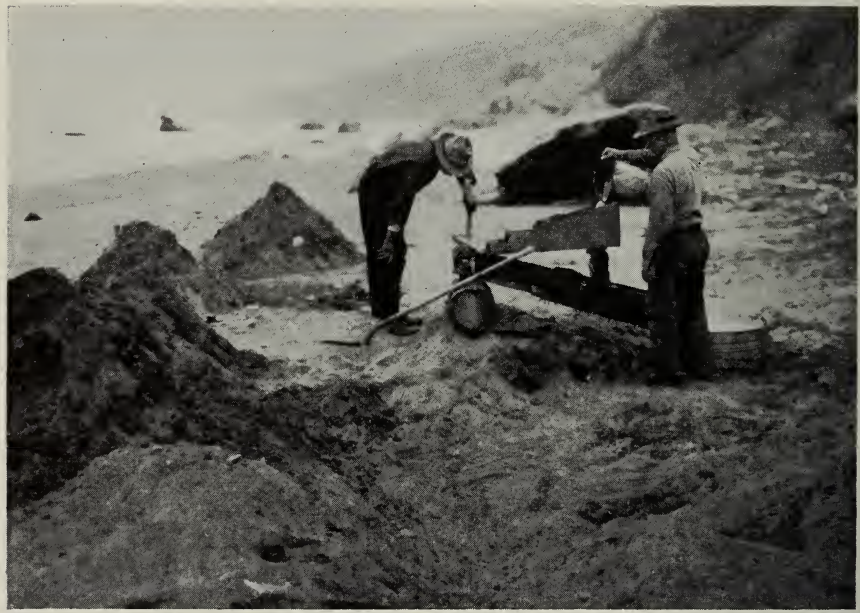


FIG. 1. Small-scale recovery of gold from beach-sand with dip box.

Later a dredge equipped with a clamshell bucket was operated at the place described above. A washing-plant fed by a hopper on a separate barge was provided; and the first concentration of the sand was made on coconut matting in sluices 36 inches wide. A second concentration was made on Wilfley tables. Part of the gold was amalgamated on plates, and part had to be cleaned of fish-oil with lye before it could be amalgamated. This dredge paid operating expenses only for some months. Trouble was experienced with the tailing, which flowed back into the working-pit. Much of the sand seen on the beach today is tailing from this dredge. The dredge was wrecked years ago.

Other efforts to work the beach-sand on a large scale with machinery have been unprofitable. Success with the sand has so far been dependent on making a careful selection of high-grade concentrations; and this can be done only by small-scale methods.

Black sands collect in the riffles at the hydraulic mines; and much of this sand carries gold and platinum. Many operators of such mines make no effort to recover platinum because of the large amount of labor involved. However, a little platinum is produced nearly every year.

Recent work on the beach sands is mentioned herein under the heading of gold: Crothers Property, Two States Mining Company.

Bibl: State Mineralogist's Reports XIV, p. 391; XXI, pp. 300-01; State Division of Mines Bull. 45, 85, 92. U. S. Geol. Survey Bull. 260, 285, 315; Mineral Resources, 1905; Geologic Folios 89, 73. U. S. Bureau of Mines Tech. Paper 196.

BRICK AND TILE.

Thompson Brick Company (formerly Eureka Brick and Tile Co.) is owned and operated by J. D. Thompson, 1506 Vernon Street, Eureka. The plant is in Sec. 24, T. 5 N., R. 1 W., one and one-half miles east of Eureka. Clay is excavated by scrapers in pits 12 ft. deep near the plant. It is dumped into a hopper and elevated to a pug mill and disintegrator. From the pug mill, the material is fed to a Brevan stiff-mud wire-cut machine, which delivers the green brick or tile to boards for stacking and drying. They are allowed to air-dry for about two weeks and are then burned in a 30-ft. round, down-draft kiln, having a capacity of 75,000 brick. Wood and oil are used for fuel, the oil at the finish of the burn, giving a temperature of 1850°. Capacity of the plant is 12,000 brick per day or 30 tons of drain-tile; but the demand is not great enough to justify full-time operation. Drain-tile is made in diameters of 3, 4, 5, 6, or 8 inches with lengths of 12 inches.

Bibl: State Mineralogist's Report XXI, p. 301.

CHROMIUM.

Hoopa Indian Reservation. J. M. Walters, Hoopa Indian Agent, Hoopa, California, states that chromite float has been found in the reservation on the top of Hostler Ridge, Sec. 15, 23, T. 8 N., R. 5 E., H. M. Mineral lands in the reservation may be leased.

Horse Mountain Copper Glance Consolidated (Horse Mountain Copper Co.) is the name of a group of 50 unpatented claims in Sec. 33, 34, T. 6 N., R. 4 E., held by H. T. Weaver, General Delivery, Eureka. Chromite occurs in a series of lenses along a ridge, on the northern part of this group, at an elevation of 4600 ft. Several hundred tons of chromite containing 40% to 45.5% Cr_2O_3 was mined and sold at a profit during the war of 1914-18. Weaver states that additional chromite was in sight in the cuts at the time of the collapse of the market. Sloughing and caving of the cuts prevented examination in 1940. A large body of basic igneous rock partly altered to serpentine exists not only on this group of claims but in much of the adjoining region. The probability is strong that additional bodies of chromite can be found.

Bibl: State Mineralogist's Report XXI, pp. 301, 307; Bull. 76, p. 148; Bull. 91, p. 109.

Little Wilder Creek. Victor Bonnefoy, Albuquerque, New Mexico, states that chromite float has been found near this creek, in a serpentine belt one-quarter mile west of the Liberty Mine, which is in Sec. 1(?), T. 11 N., R. 5 E. He planned to prospect for the source of the float, but so far as we know this has not yet been done.

CLAY.

Bulletin 99 of this division, ''The Clay Resources and the Ceramic Industry of California,'' by Waldemar Fenn Dietrich, Associate Professor of Mining Engineering, Stanford University, includes about five pages describing the clays of Humboldt County. Eight deposits are described, and results of tests made on several of them are included.

Loofbourrow Clay Deposit is described in our Bulletin 99, and a chemical analysis of it is included in State Mineralogist's Report XXI, p. 302. The deposit was formerly owned by the late Dr. T. L. Loofbourrow of Eureka, but is now assessed to Mike Santelli. It is in Sec. 4, T. 4 N., R. 1 W., H. M.

Common clays suitable for the manufacture of brick, hollow tile, and roofing tile are found at many places in Humboldt County, particulary in the vicinity of Arcata and Eureka. Places from which small lots of clay have been obtained by R. H. Jenkins for pottery-making in his classes at Humboldt State Teachers College, Arcata, are as follows: (1) Hungry Hollow, Sec. 20 (?), T. 6 N., R. 3 E. (2) Table Bluff near Loleta. Clay crops out on the road between Beatrice and Loleta in or near Sec. 5, T. 3 N., R. 1 W. (3) Near the Big Four Inn. The burned clay is of a lighter shade of red than the original clay. (4) Near Trinidad, on the beach, north of the road leading to the lighthouse. (5) Patrick Point on the path to Big Lagoon Beach. (6) Sec. 30, T. 10 N., R. 1 E., Dry Lagoon Drive and north along beach.

COAL (LIGNITE).

Coal or lignite has been known to exist in Humboldt County since about 1860. From time to time new localities where it occurs have been reported and placed on record, but no commercial production has been recorded. Market conditions have not been such as to encourage development. Lignite comparable in quality with that found elsewhere in California can probably be produced if a demand for it should appear. However, possible commercial value of the deposits remains undetermined because of the lack of underground development-work.

A list of 18 places where lignite has been found is contained in State Mineralogist's Report XXI, pp. 303-05. The width of many of the seams mentioned is too small for commercial mining.

Hoopa Coal Mining Company, Frank Thompson, president, M. R. Green, Eureka, secretary, held a lease on the Hoopa Indian Reservation, Sec. 3, T. 8 N., R. 4 E., H. M., in 1940. A new slope was driven on this lease, which is on the west side of Trinity River, four miles down the river from Hoopa, and at an altitude of about 300 ft. higher than the road along the river. Surface-caving and dumps indicate that at least two other slopes were driven years ago. They are about 50 ft. away on each side of the new slope. The new workings were full of water at the time of our visit.

M. R. Green states that the new slope was driven in the footwall of a series of lignite veins at an angle of 27° below horizontal for a distance of 60 ft. It was then flattened to an angle of 10° below horizontal and continued for a distance of 67 ft. At this point a width of 7 ft. of lignite is stated to have been found, but just beyond this showing the deposit was so much disturbed by faulting that the lease was abandoned late in 1940. A few tons of lignite on the dump showed the grain of the original wood.

Green has furnished the following analyses:

	By Smith-Emery, Jan. 28, 1935	By the University of Nevada	
Moisture	17.26%	--	9.7%
Volatile matter	42.11	58.85	39.5
Fixed carbon	34.15	35.91	48.0
Ash	6.48	5.24	2.8
Sulphur	0.63	--	--

Maple Creek Deposit. An early patent for coal was granted to 80 acres in Sec. 20, 29, T. 5 N., R. 3 E., H. M., on Maple Creek. A seam of tough brownish-black lignite dips 45° NE. The width is not known, but it is thought to be three to four feet. Analyses of this lignite are contained in State Mineralogist's Report XXI, pp. 303-04.

COPPER.

Horse Mountain Copper Glance Consolidated (Horse Mountain Copper Co.) is the group-name given by H. T. Weaver, General Delivery, Eureka, to 50 unpatented claims that he relocated in 1933. They are in Sec. 33, 34, T. 6 N., R. 4 E., H. M. and are reached by means of 5½ miles of steep mountain road turning from the Redding-Eureka highway.

Weaver states that the last extensive development work was done in 1929 and that underground workings have a total length of 7000 ft. When most of this work was being done, the property was equipped with buildings to house 200 men, a mill driven by two 50-hp. steam boilers for concentrating the ore, saw mill, and assay office. All of the machinery has been removed and many of the buildings have been wrecked. Four buildings suitable for living quarters remain. Production of copper has been small.

According to Weaver, the lowest adit, at the level of the main camp, is 1950 ft. in length. All of the underground workings were caved at the time that he relocated the claims, to the extent that he was unable to enter them.

Country rock exposed in open cuts scattered over many claims shows plentiful green malachite-staining along fractures. Chalcocite is found on some of the dumps. One cut re-opened by Weaver exposes a vein of chalcocite ranging in width from a few inches to nearly a foot. The vein is exposed for a length of about 10 ft. Country rock is serpentine cut by gabbro dikes.

Production of chrome ore from these claims is mentioned herein under the heading of 'chromium'.

Bibl: State Mineralogist's Reports XIV, pp. 395-99; XXI, pp. 305-08.

Red Cap Mine is in Sec. 29, T. 10 N., R. 6 E., H. M., on the ridge between Red Cap and Boyce Creeks. Rich float consisting of native copper and bornite was found, and considerable prospecting was done years ago. No production of importance has resulted. The *La Perin* group of 10 claims adjoined. Country rock is serpentine. Native copper found in the riffles of the Nichols placer mine, a few miles down Red Cap Creek, may have originated here.

Bibl: State Mineralogist's Reports XIV, pp. 395-96; XXI, p. 305.

Copper as chalcopyrite has been found on the *Hoopa Indian Reservation* in Sec. 2, T. 8 N., R. 4 E., H. M. A few years ago, persons interested in the gold content of the ore rather than the copper drove a 300-ft. adit. A vein of heavy sulphide ore is said to have been exposed in widths as great as seven feet. The adit had caved at the time of our visit. The ground was open for a lease in 1940.

GOLD.

Bergin Placer Property of 1485 acres in Sec. 3, 4, 5, 8, 9, 10, 15, 16, 17, T. 6 N., R. 5 E., H. M., is held by John W. Bergin, Weaverville. It is near the Eureka-Redding highway, 60 miles east of Eureka. The unpatented claims cover terrace-gravels of Trinity River for a length along the river of three and one-half miles. A few years ago, options were taken on the claims by *Mines Exploration Company,* T. N. McDaniel, president. Application was filed for a diversion of 150 second-feet of water from Willow Creek for use in hydraulic mining. Plans called for a diversion-dam at an elevation of 1450 feet and seven miles of 4-ft. by 6-ft. flume with a 52-inch inverted siphon; but only surveys and other preliminary work were completed. George S. Young, mining engineer of Oakland, was consultant. Property of Swanson Mining Corporation (Salyer Consolidated) adjoins, and is just across the Humboldt-Trinity county line.

Bondo Mine (Croton Bar and Markeson) in Sec. 29, T. 11 N., R. 6 E., one and one-half miles up the river from Orleans, is held by S. F. Woodson, Orleans. It is an old hydraulic mine on terrace-gravel of Klamath River, and early work is said to have been profitable. Ditch and flume have recently been repaired and two small giants set up; but the mine was idle at the time of our visit in the spring of 1940.

Bibl: State Mineralogists's Reports XIV, p. 401; XXI, p. 309.

Chilton Mine in Sec. 34, T. 11 N., R. 6 E., is held by H. Warner, Orleans. The mine is three miles by trail up Pearch Creek from the highway running from Orleans to Somes Bar. Altitude of the claims ranges from 3000 ft. to 4000 ft. or roughly 2500 ft. higher than Klamath River.

A quartz-filled fissure vein strikes S. 50° E. and dips about vertically. It has been worked from adits, open cuts and stopes through a vertical range of 50 ft. and a length of 200 ft. The vein ranges in width from a narrow seam of gouge to several feet of quartz, gouge, and country rock. It has been stoped to a width of 4 ft. in places. Country rock is a fine-grained igneous rock, probably andesite. Ore is sacked and sledded down a quarter of a mile of steep mountain trail.

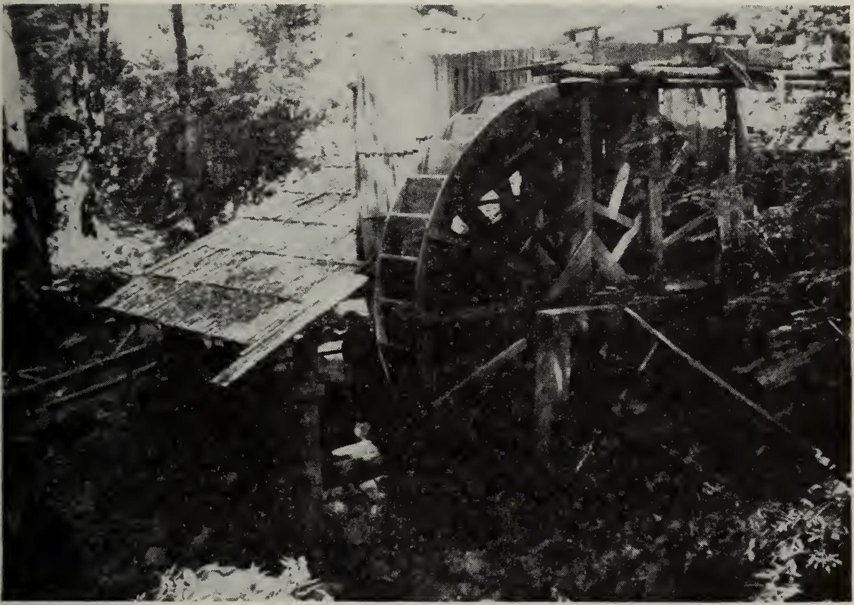


FIG. 2. Mill at Chilton Mine.

Equipment includes a Straub sectionalized Little Giant Ribcone Mill. This is a ball mill about 30 inches in diameter by 18 inches long. It is driven by an overshot water wheel. A jaw-crusher had been in use but was not connected to the water wheel at the time of our visit. Treatment consists of amalgamation on plates.

Crothers Property (Johnson Place) covers one and one-half miles of ocean-beach near the Humboldt-Del Norte county line in Sec. 33, T. 13 N., R. 1 E., and Sec. 4, T. 12 N., R. 1 E., H. M. J. H. Crothers, 328 E Street, Eureka, owns 120 acres and one-half interest in 200 acres additional. In July, 1940, one man was making a living from the beach-sand by means of washing it with a dip box and salt water. Gold was recovered by means of expanded metal lath of about one-quarter inch mesh over burlap and canvas. Crothers stated that John W. Sword, 367 Euclid Avenue, Oakland, was planning to install equipment for work on a larger scale.

Harveston Bar Mine includes 40 acres of mining ground and additional agricultural land in Sec. 20, 21, T. 11 N., R. 6 E., owned by F. Brace, Orleans. A terrace of Klamath River, 200 ft. higher than the present stream, is mined by means of a hydraulic giant using either a 2-inch or 3-inch nozzle-opening. Water to the amount of one cubic foot per second is taken from Wilson Creek through a mile and a half of ditch. Pipe in sizes of 8-inch and 10-inch carries the water to the mine to give a head of 150 ft. Two men work during the water-season.

Hoopa Indian Gold Mines is the name of an organization that planned to work a vein in Sec. 2, T. 8 N., R. 4 E. The vein carries much chalcopyrite, and has been mentioned above under the heading of 'copper'. The ground was open to a lease in the summer of 1940.

Hoopa Indian Reservation contains an undeveloped quartz vein in Sec. 14, 23, T. 9 N., R. 5 E., at a hairpin bend on Mill Creek. According to J. M. Walters, Indian Agent, Hoopa, California, assays of a little more than an ounce of gold per ton have been obtained. The ground is open for a lease.

Klamath View Group of four claims in Sec. 20, 21, T. 11 N., R. 6 E., is held by G. W. Davis, Orleans. The Klamath River road, Yreka to Eureka, crosses the lower part of the claims. Elevations range from 800 to 2000 ft. Lenses of quartz in schist are said to give good assays in gold. An upper adit, 28 ft. long, follows a quartz vein with a width of 4 inches to a foot. About 50 ft. lower in elevation is a 50-ft. adit that was intended to cut the same vein, but the objective had not been reached at the time of our visit. Prospecting was being done at a point 1000 ft. lower, but several hundred feet higher than river-level, by means of cuts and a 20-ft. adit. They exposed surface slide-rock and the underlying green schist, which is the predominant country rock of the area.

Liberty Mine of four unpatented claims in Sec. 1(?), T. 11 N., R. 5 E., H. M., is held by F. W. Harley, Orleans, and is optioned to Victor Bonnefoy, Albuquerque, New Mexico. The property is on Little Wilder Creek, 10 miles by mountain road from Orleans, at an elevation of 3000 ft. The last one-half mile is trail.

An adit, 175 ft. in length, follows a quartz vein but develops practically no backs because it is parallel to the creek. The white quartz ranges in width from 2 ft. to 7 ft., averaging 4 ft. It contains iron oxides weathered from original sulphides, and is said to assay $10 per ton in gold. The strike is N. 55° E., and the vein dips steeply SE. Walls are chloritic schist. Open cuts show that the vein extends several hundred feet to the northeast of the face of the main adit. The vein strikes into the hillside at the northeast end, and backs could be gained by means of a new adit. However, the gold content is said to be lower at this end than in the present adit.

An attempt to mill the quartz on a small scale was made some years ago, but little production resulted. Equipment consists of a cabin and hand-tools. Only assessment work has been done recently.

Mule Trail Placer in Sec. 10, T. 10 N., R. 5 E., H. M., is held by Harvey Van Pelt, Orleans; J. K. Lewis, O. C. Hyde, Ted Florian, San

Francisco. It is a recently discovered placer deposit, apparently a terrace of Klamath River, at an elevation of 1500 ft. or more than 1000 ft. higher than the present river. The mine was equipped for operation during the season 1940-41. A ditch, one and one-half miles in length, picks up water from gulches to supply a No. 1 giant with 2-inch nozzle-opening. Three hundred feet of 11-inch pipe gives a head of 150 ft. According to Van Pelt, substantial amounts of gold have been developed by means of a trench, 600 ft. long, 4 ft. wide, and 20 ft. deep. Gravel ranges in depth from 15 ft. to 18 ft.

Murray Mine (Nelson) in Sec. 4, 9, T. 11 N., R. 6 E., is owned by Estate of L. J. Nelson, c/o P. L. Young, Orleans, and is being worked under a lease and option by Dayton Murray and others, 8th and B Streets, Eureka. The mine is six miles up Klamath River from Orleans on the opposite side of the river from the state highway. It is served by a road maintained by U. S. Forest Service. The property is an old hydraulic mine, which has been worked on and off for many years. Present work is intended to re-open a terrace about 50 ft. above river-level that was covered by a slide in 1927. Gravel is said to be 20 ft. deep. Older pits and boulder-piles on a terrace about 100 ft. higher are to be seen. Bedrock is serpentine.

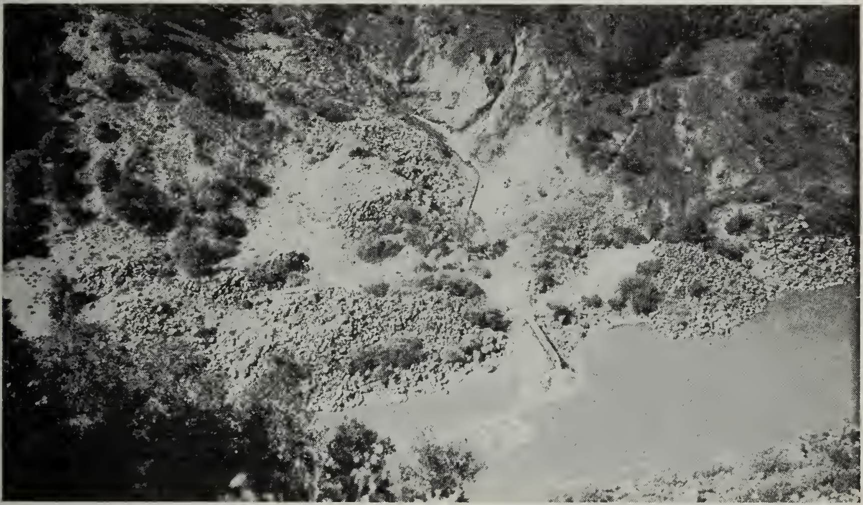


FIG. 3. Murray Mine from highway on opposite side of Klamath River.

Water from Mud Creek and Angelino Creek is collected in three reservoirs and is delivered to the mine through one and one-half miles of ditch and flume. New flume of a length of 2000 ft., 24 inches by 12 inches, and 30 inches by 12 inches, was built recently. One hydraulic giant with 5½-inch nozzle-opening was in use in 1940. Part of the available head was wasted by letting the water flow down a creek-bed. Alterations were planned to give a head of 200 ft. for 1000 miner's inches of water. Plans also called for raising dams at reservoirs to supply water for two shifts instead of one. A high-line cable and hoist powered by an automobile engine are provided to pile boulders of a maximum weight of two tons.

Gold is recovered in a new sluice, 250 ft. long, and 30 inches by 30 inches in section, equipped with rails and wooden blocks for riffles. Gravel below one-half inch in size goes to an undercurrent, 4 ft. by 12 ft. Three to six men under James Sage work from October to June.

Nichols Mine comprises three 80-acre mining claims in Sec. 24, T. 10 N., R. 5 E., owned by L. R. Nichols and G. F. Willhite, Orleans. The property covers terrace and stream gravels of Red Cap Creek, eight miles by road from Orleans, at an altitude of 1000 ft.

Early in 1940, a pit roughly 150 ft. by 100 ft. by 8 ft. deep had yielded $700 in gold. The excavation was made with a Caterpillar 60 gasoline tractor and bulldozer scraper on a terrace 90 ft. higher than the present stream. Gravel was pushed to a stationary grizzley made of wooden poles, and fines were washed in a riffle-sluice 14 inches wide by 12 inches deep with a grade of 22 inches to the 12-ft. box. Water was raised through 8-inch galvanized steel pipe from the main creek by means of a centrifugal pump driven by a Buick automobile engine. Bedrock is slate, which is soft enough in most places so that a foot of it can be scraped off by the bulldozer. A crew of four men was employed on this work.

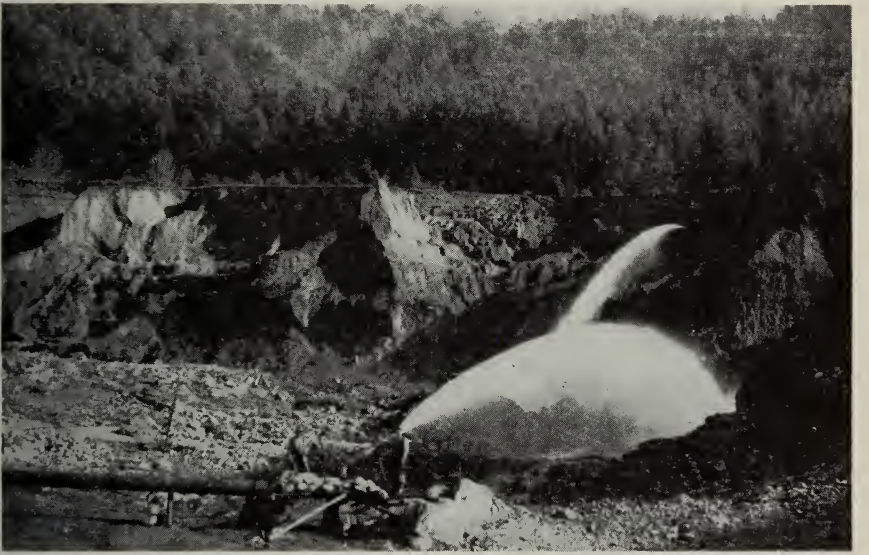
Plans call for the installation of a one-cubic-yard dragline outfit to work bars of the present stream, which are said to be much higher in grade than the gravels of the terrace.

Orleans Placer Mine (Bar Placer Mining Co., Stony Bar Mining Co.) is a tract of 160 acres on low river-bars and present stream-channel of Klamath River in Sec. 1, T. 10 N., R. 5 E., Sec. 31, T. 11 N., R. 6 E., Sec. 6, T. 10 N., R. 6 E., Sec. 36, T. 11 N., R. 5 E., H. M. The tract was patented in 1880 by Thomas Baird and is now owned by J. H. Crothers, 328 E Street, Eureka, and others. Some drilling was done in 1939 by R. F. Felchlin, Grant-Pacific Rock Company, G and Divisadero Streets, Fresno, to develop the gravel for dredging. The land extends from a quarter of a mile below Orleans down to Camp Creek mostly on the northwest bank of the river but a part of it extends across the river.

Owl Mine in Sec. 34, 35, T. 11 N., R. 5 E., is held by William Sorenson, Orleans. The tract contains 200 acres, of which about 65 acres contain gravel of an old terrace of Klamath River, 900 ft. higher in altitude than the present stream. The property is two miles down the river from Orleans at an elevation of 1300 ft. It has been worked by hydraulic mining in the past with water from Ullathorne Creek supplied through three miles of ditch and one-half mile of flume. This is considered inadequate, and plans call for the construction of two and one-half miles of ditch from Crawford Creek to give 200 ft. of head at the mine. A 25-ft. bank formerly mined has caved. Equipment includes one No. 2 giant and 500 ft. of 15-inch pipe. The mine was idle at the time of our visit, and information on it was furnished by Fred M. Colby, Orleans.

Pearch Mine of 180 acres in Sec. 32, T. 11 N., R. 6 E., formerly owned by P. L. Young, Orleans, has been sold to Roy McGain, Orleans, who is operating it. The property is one mile northeast of Orleans on the dirt highway to Happy Camp. An old terrace of Klamath River with bedrock about 50 ft. higher than the present river contains a placer deposit 80 ft. thick at the face of the present hydraulic pit. Only the lower part of the deposit is gravel with boulders of a maximum diameter of 18 inches. Overlying this is a great thickness of fine overburden and soil. The slate and chloritic schist bedrock dips steeply in several directions.

During the water-season the mine is kept in operation for 24 hours per day by a crew of 10 men. A mile and one-half of flume from Pearch and Cheney creeks has a capacity of 1300 miner's inches with a head of 225 ft. at the mine. Three giants are set up, one with 6-inch nozzle-opening, the other two with 5-inch. They are supplied with water by means of 840 ft. of 36-inch and 30-inch pipe, 900 ft. of 20-inch pipe, and 2800 ft. of 15-inch pipe. Gold is recovered by means of wood-block riffles in a 'Y' sluice reaching both ends of the pit and discharging to Klamath River. To reach the river from one end of the pit, 192 boxes, each 12 ft. long, are required. The 'Y' branch to reach the other end of the pit contains 94 boxes. Grade is one-half inch per foot. McGain estimates that he mines 1000 cu. yd. per day during a working-season of five to six months. Water wheels furnish power for compressed air and electric lights.



(Photo by courtesy of Roy McGain)

FIG. 4. Pearch Mine.

Production for 1939 is given by the U. S. Bureau of Mines [1] as follows: ''Cleaning bedrock at the Pearch hydraulic mine on the Klamath River northeast of Orleans yielded 154 ounces of gold and 23 ounces of silver.''

Bibl: State Mineralogist's Reports XIV, p. 404; XXI, p. 315.

Two States Mining Company (Gold Bluff, Whitlock), Frank Meyers, president, Seattle, Washington, holds an option on beach-property of Singer Sewing Machine Company, Eureka. Five miles of beach are said to be controlled. A new plant for the recovery of gold from the beach-sand has been built in Sec. 8, 17, T. 11 N., R. 1 E., seven miles by dirt road from Orick. A. Lynch, Box 78, Orick, was in charge in 1940.

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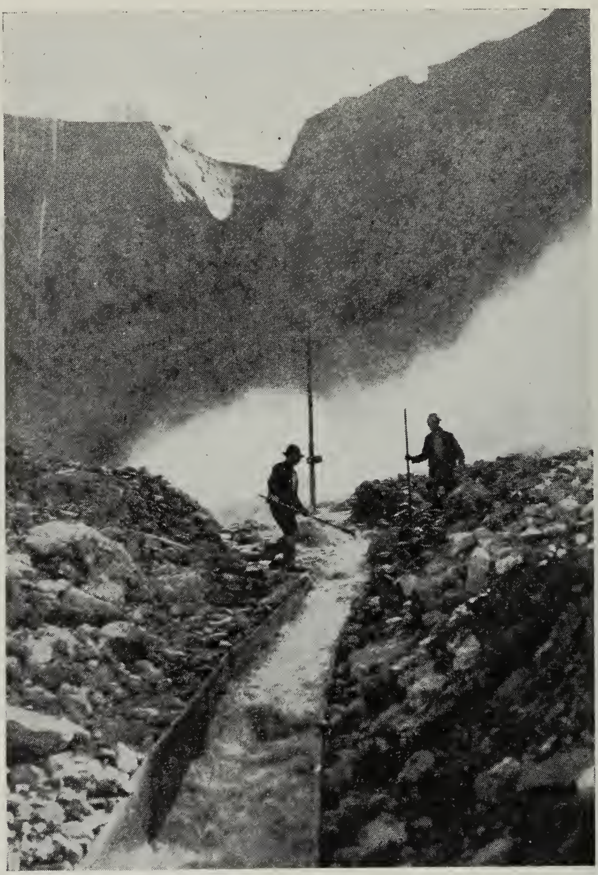
[1] Hughes, H. Herbert, U. S. Bureau of Mines, Minerals Yearbook 1940, p. 233.

The plant includes a slack-line excavator with 1½-cu. yd. bucket, operated with 125-hp. steam donkey-engine fired with oil. Rocks and pebbles over one-half inch in diameter are rejected by dumping the sand on a double grizzley. Undersize is carried by water through a sluice to two Bendelari jigs, 42 inches by 48 inches, made by Denver Equipment Company. These are roughers, and the concentrate is cleaned in another jig, 10 inches by 11 inches. Further treatment is by amalgamation in a barrel, 5 ft. 2 inches long by 2 ft. 6 inches in diameter; also by amalgamation on plates. Power for the jigs and barrel is furnished by an automobile engine. Fresh water is pumped from a pond on the property with a 10-inch centrifugal pump driven by a Ford V-8 engine. Used water is returned to the pond.



(Photo by courtesy of Roy McGain)

Fig. 5. Sluice at Pearch Mine.

Only a short test-run had been made at the time of our visit. Lynch stated that the recovery was 35 cents per cubic yard and that considerable gold was lost in the tailing. This is thought to be caused in part by lumps of clay discharged from the grizzley, and plans call for additional equipment to break up the lumps. Estimated capacity of the equipment is 100 buckets of 1½-cu. yd. capacity per 8-hour shift.

Bibl: State Mineralogist's Report XXI, pp. 300-301.

Weitchpec Bar Mine is a small hydraulic mine just below the confluence of Klamath and Trinity rivers, on a small bar near river-level, in Sec. 10, T. 9 N., R. 4 E., H. M. C. C. Gillespie of Weitchpec and one other man worked during the season of 1939-40. A giant with a 3-inch nozzle-opening is supplied with water from Gist Creek under about 100 ft. of head. Flood-waters of the winter 1939-40 covered the gravel with about 10 ft. of sand, and work during the season consisted largely of removing the sand.

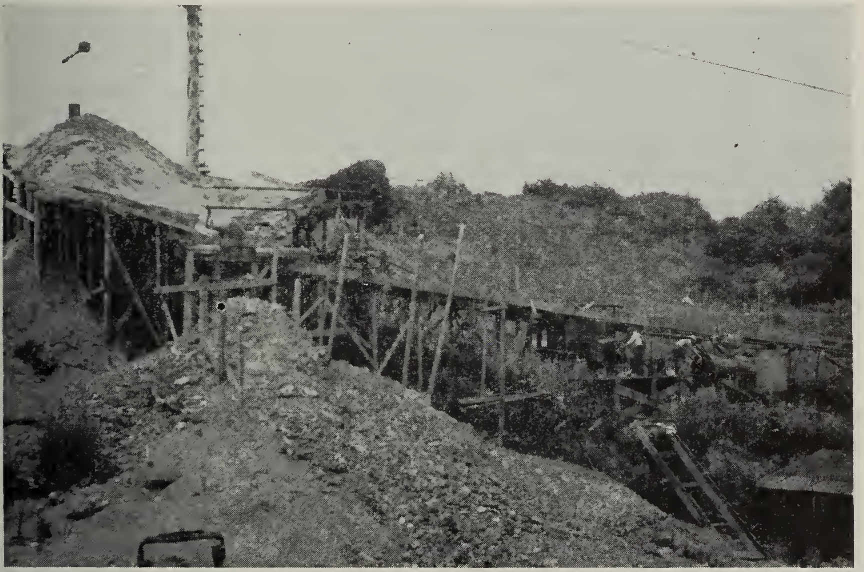


FIG. 6. Two States Mining Company.

Bibl: State Mineralogist's Reports XIV, p. 407; XXI, p. 317.

White Horse Mine comprises the Red Top, Orleans, Horned Owl, Klamath Pride, Brown Iron, White Horse quartz claims and a millsite on Five Mile Creek near the highway from Orleans to Happy Camp. The claims are in Sec. 16, T. 11 N., R. 6 E., and are held by George William Smith, Etna; A. W. McBride, Orleans; and others.

Gold Cord Development Company held an option on the White Horse mine in 1939. C. A. Bartholf was president, and Pearl Horning was secretary.

About 1000 ft. of underground development work has been done on a quartz vein striking N. 50° E. and dipping 60° SE. At the portal of the main workings the vein is in three strands with a width of about

5 ft. of quartz in a total width of 8 ft. Country rock is dioritic. These main workings are 1000 ft. higher in altitude than Klamath River and are reached by trail. Part of the white quartz is stained brown by oxides of iron, and a little is stained green by malachite. McBride states that the quartz gives good assays in gold. Only assessment work is being done.

IRON.

Occurrences of iron ore have been noted in past reports of the State Mineralogist notably on property of W. A. Preston, Arcata, in the NE¼ Sec. 28, T. 6 N., R. 1 E., adjoining the townsite of Arcata. No commercial development of the deposits has been undertaken.

Bibl: State Mineralogist's Reports XII, p. 326; XXI, p. 318; Bull. 91, p. 101.

LIMESTONE.

Hackett Property is in Sec. 10, 16, T. 1 N., R. 1 W., 14 miles southeast of Ferndale, on the west fork of Howe Creek, and is owned by Walter E. Hackett, R. F. D., Ferndale. There is no road for the last two miles, and one must walk through steep country over the boulders in the stream. Limestone crops out on the steep bank of the stream for a width of 20 ft. and a height of 30 ft. Only a very rough idea of the dimensions can be obtained because no work has been done, and much of the limestone must be covered by soil overburden. Boulders of limestone in the creek, measuring 4 ft. by 5 ft., have evidently fallen from the bank above. Limestone in the center of the exposure is white and appears to be of good grade. At the edges it grades into gray and red varieties that evidently contain clay and oxides of iron.

Jacoby Creek Deposit is on a large tract of land in Sec. 13, 14, T. 5 N., R. 1 E., and Sec. 19, T. 5 N., R. 2 E., owned by F. B. Barnum, Inc., and R. W. Bull, 203 Fifth Street, Eureka. The tract is 10 miles northeast of Eureka near Bayside. C. P. Drake, P. O. Box 386, Eureka, held a lease on the limestone in 1940. Limestone, probably of Franciscan age, crops out with dimensions approximately as follows: 20 ft. by 50 ft. by 15 ft. deep. This amount can actually be seen above ground-level. Probably additional limestone can be developed in depth. The wreckage of an old brick kiln for burning lime is to be seen near the outcrop. The side of the canyon of Jacoby Creek affords a good site for a quarry-face. The last mile of road needs rebuilding. A second lens of limestone of similar size is said to occur nearby, but it was not shown to the writer.

The following analysis of this limestone is from State Mineralogist's Report XIV, p. 394:

SiO_2	1.41%
Lime, CaO 53.61%; $CaCO_3$	95.74%
Fe_2O_3	0.35%
Al_2O_3	0.56%
MgO	Trace
Water	0.01%
Residue from carbonaceous matter	0.50%
	98.57%
Volatile, CO_2, H_2O, etc.	42.40%

Bibl: State Mineralogist's Reports IV, p. 109; VI, pp. 23, 98; VIII, p. 216; XIV, pp. 393-394; XXI, pp. 318-319.

Johnston Deposit is in Sec. 4, 9, T. 2 S., R. 1 W., H. M., eight miles by steep mountain road from Petrolia. It is on a large tract of which 1720 acres is owned by Johnston Estate and 320 acres by T. A. Johnston, Petrolia. Twenty to 25 tons of limestone outcrop on a steep hillside. Smaller outcrops are found a mile to the northwest and a mile to the southeast, which is the strike of the formation, probably the Franciscan.

McClellan Deposit in Sec. 5, T. 1 N., R. 1 W., is on a 200-acre patented tract owned by E. S. McClellan, Waddington. It is five miles up Price Creek from Weymouth Inn by a steep mountain road. A white deposit, soft, light, and porous, is found covering an acre of land to a depth of 3 ft., possibly a little more in places. Where seen in a road-cut, it was 3 ft. deep, and soil was beneath it. McClellan states that he dug a 3-ft. hole in another place, and still had the white deposit in the bottom; also that an analysis has shown that it is 99 per cent calcium carbonate. It is evidently a deposit of calcareous tufa from springs, one of which may still be active. McClellan uses small quantities of it as limestone on his ranch.

Rickter Deposit in the SE$\frac{1}{4}$SE$\frac{1}{4}$ Sec. 11, T. 1 N., R. 1 W., is owned by Mrs. Matilda Rickter, Rio Dell. It is reached by means of two miles of oiled road and one-quarter mile of dirt road from Rio Dell. A quarry, 75 ft. in length, in soft limestone, was opened about 1915. The height of the face is 25 ft. in the center, but it slopes down to floor-level at both ends. The limestone was ground and sold for agricultural use. This old quarry is on a low ridge, and small pieces of float indicate that the deposit may extend up the ridge for several hundred feet, and also for a short distance down the ridge. The total length may possibly be 1000 ft., but stripping is needed to show whether or not the limestone is in place below the overburden, and whether it is of good quality. Additional depth of more than 100 ft. can be obtained by extending the floor of the quarry in the direction of the higher part of the ridge.

Three Creeks Limestone Deposit in Sec. 33, T. 7 N., R. 4 E., is owned by J. B. Pascoe, 2805 J Street, Eureka, and others. The distance to Arcata by the best road is 51 miles; but this could be shortened considerably if an old county road reaching the deposit from the summit to the west were put in good repair. Limestone boulders, mostly about a foot in diameter but some weighing several tons, occur in two areas each 200 ft. to 300 ft. long and 100 ft. to 200 ft. wide, and in two smaller areas. It is marine limestone, which Harry MacGinitie[1] of Humboldt State Teachers College at Arcata states is Devonian. The largest area of boulders is on a hillside that appears to offer a chance to open a quarry. Chert with a steep dip lies to the west to make up a thickness of a few hundred feet, then serpentine. A forest road passes through the property. No development work has been done on the limestone.

White Rock Limestone Deposit in Sec. 18, 19, T. 6 N., R. 5 E., H. M., was held in 1940 as 40 acres of unpatented mining claims by Alexander Brizard, Arcata. The distance to Arcata is 53 miles mostly state highway but partly U. S. Forest Service road. Limestone crops out as the backbone of a ridge, and is seen in dimensions of approximately 800 ft. long, 145 ft. wide, and 50 ft. deep. The dip appears to be steep, and probably much more depth can be developed. The road passes through the claim at an elevation 200 ft. lower than the limestone outcrop. Hence trucks could be loaded cheaply. An analysis made by Smith-Emery Co. for Brizard follows. The sample analyzed was fresh limestone. Weathered surfaces were removed.

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[1] Oral communication.

SiO_2	0.34%
Al_2O_3	0.16%
Fe_2O_3	0.13%
MgO	0.53%
CaO	54.88%
Purity as $CaCO_3$	97.95%

White Woman Limestone Deposit in Sec. 20, 29, T. 4 S., R. 5 E., is owned by A. A. Smith, Harris. It is two and one-half miles by an old road northeast of Harris. Cost of rebuilding one small bridge on this road is estimated by Smith at $100. Harris is 11 miles by mountain road from the State highway at Garberville. Smith states that the white limestone crops out as a cliff 35 ft. long and 10 ft. high. Smaller croppings occur at intervals for a quarter of a mile. Specimens appear to be of good quality.

Willow Creek. Several undeveloped outcrops of limestone have been noted along the State highway on Willow Creek, T. 6 N., R. 4 E. Prospecting and development work would quite possibly result in opening up a deposit large enough to quarry.

MANGANESE.

Fort Baker Mine (Porter Ranch) is on a tract of thousands of acres of patented agricultural land owned by Russ Investment Company, 3d and G Streets, Eureka. Rex L. McBride is president and L. V. Smith is secretary. The deposit is in Sec. 31, T. 3 N., R. 4 E., H. M., 36 miles by dirt road with some steep grades from Carlotta, which is on the Red Bluff-Eureka highway, and on a branch line of the railroad.

Black manganese oxides occurring in Franciscan chert have been mined by means of open cuts, shallow shafts, and tunnels scattered over about an acre of ground. According to J. H. Collier, who has recently made a report on the property, the grade was raised by screening the ore and shipping the fines. He thinks that the fines contained a high percentage of pyrolusite. Probably hand-sorting was done also. A sample taken by Collier from one of the best streaks of soft, friable ore, one foot in width, containing no visible silica, was shown by analysis to contain 58.38% manganese and 3.56% silica.

Caving makes examination difficult even at the surface and impossible in underground workings. A lens of manganese oxides, 8 ft. in width, strikes northeast and dips 60° NW. A parallel lens about 10 ft. away is lower in grade but is about 15 ft. wide. A tunnel and shafts tapped the deposit at a depth of 40 ft. below the surface, but only a little drifting was done. The following incomplete data on shipments were furnished by a former operator:

Year	Railroad cars	Mn	SiO_2
1920	6	47.26%	13.40%
1918	12	50.58	9.21
1918	12	47.26	13.40

Bibl: Calif. State Division of Mines Bull. 76, pp. 33-34.

Fort Seward Mine in Sec. 15, T. 3 S., R. 4 E., is on land now assessed to M & T, Incorporated, G. S. Towne, president, 353 Sacramento Street, San Francisco. Manganese ore was produced during the war of 1914-18.

Woods Mine (Charles Mountain) in Sec. 2, 11, T. 1 S., R. 4 E., is on a large tract of patented grazing land owned by Russ Investment Company, 3d and G Streets, Eureka. Rex L. McBride is president and L. V. Smith is secretary. Mineral rights to the manganese deposit are held by the same company by means of five mineral locations of 20 acres each. Altitude is 3400 ft., and the distance to Bridgeville on the Red Bluff-Eureka highway is about 20 miles. The last four miles of the road near the mine is now in the condition of a pack-trail. A small amount of work with modern road-building machinery would put it in condition for use by trucks. Ore was formerly hauled to Ft. Seward, a distance of 20 miles, by truck.

Black manganese oxides are found in chert on the top of a ridge. At the north end of the ridge are three adits in a total vertical distance of 100 ft. They are probably each about 100 ft. long but are caved, and little can be seen of the deposit. At the portal of the lowest adit is a pile of about 15 tons of black manganese ore. A sample of this recently taken by John H. Collier, mining engineer, may be a little better in grade than the average of the pile. Analysis showed the sample to contain 52.05% manganese and 10.42% silica. Around the ridge, on the east side, at a distance of about 200 ft., and at the same general altitude as the adits mentioned are several open cuts and a short adit from which manganese ore has been mined. A few other small outcrops are seen at intervals along the ridge to the south and southwest for a distance of nearly a mile.

Incomplete data on shipments furnished by a former operator are given below. Probably earlier shipments were made during the war of 1914-18. Data on shipments do not show whether or not the ore was hand-sorted, but probably it was.

Year	Railroad cars	Mn	SiO_2
1920	14	46.08%	13.05%
1920	13	44.40	14.35

Bibl: Calif. State Division of Mines Bull. 76, p. 34.

MERCURY.

(See Quicksilver)

MINERAL WATER.

Mineral water was produced commercially in Humboldt County for years, although the number of mineral springs is not great. The following springs have been described by Waring.[1] With the exception of Iaqua Medicinal Spring, they have not been visited by the writer.

Cook Spring. This spring is 35 miles southeast of Eureka on the north bank of North Yager Creek, near the point where the road crosses the stream. The water contains sulphur and iron.

Felts Spring is five and one-half miles northeast of Fortuna, in T. 3 N., R. 1 E. Three springs in the group yield saline and sulphurated water. A hotel and resort was at one time maintained here.

Humboldt Artesian Mineral Well was within the boiler-room of Flannagan's lumber mill, about one mile south of Eureka. It was six inches in diameter and 175 feet deep. The water was formerly bottled and carbonated and used as a table water for many years. It is an alkaline saline water.

Iaqua Medicinal Spring is on the waterfront at the foot of K Street, Eureka. It is no longer utilized.

Mountain View Springs is on Mad River, 28 miles southeast of Eureka. The water is strongly sulphurated.

Bibl: State Mineralogist's Reports XIV, pp. 408-410; XXI, p. 320; U. S. Geol. Survey Water Supply Paper 338.

NATURAL GAS.

Briceland Well in Sec. 18, T. 4 S., R. 3 E. has supplied gas to several buildings in the town of Briceland for many years from a depth of 780 ft. It was still in operation in 1939. See under 'Petroleum' also.

Bibl: State Mineralogist's Report XXI, p. 320.

The Texas Company, 929 S. Broadway, Los Angeles, developed natural gas on leases in Sec. 21, 22, T. 3 N., R. 1 W., two and one-half miles east of Fernbridge in 1940. C. E. Olmsted is president, and E. M. Crone, New York City, is secretary. Drilling was done under the supervision of L. Crumb. The land is owned by Holmes Eureka Lumber Company, Eureka, and others.

Natural gas can be produced from three wells in the sections mentioned above. Elevations above sea-level at the surface at the three wells are 798 ft., 693 ft., and 700 ft. Two wells are entirely shut in and the third is partly shut in. The gas is found in strata of sand at depths of 3800 to 5000 ft. Thickness of the sand strata ranges from an inch to 10 ft. Most of them are 6 inches to a foot thick. All formations penetrated belong to the Pliocene with the exception of a little Pleistocene on top. One well bottomed the Pliocene at 7700 ft. and went into the Franciscan. No Miocene was found and no petroleum. The well was plugged back to 4800 ft. Another well is 4850 ft. deep. Initial pressure of the gas is 2300 lb. per square inch.

Gas now being used is sold through the Pacific Gas and Electric Company to the Humboldt Creamery Association at Fernbridge. One of the wells is connected to the creamery by two and one-half miles of two-inch pipe. The average amount used by the creamery is 500,000 to 600,000 cu. ft. per week. This is only a fraction of the amount that the well is capable of producing. Additional wells were being drilled in the summer of 1940. The gas will probably be piped to serve the City of Eureka by Pacific Gas and Electric Company.

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[1] Waring, G. A., Springs of California: U. S. Geol. Survey Water Supply Paper 338, 1915.

PETROLEUM.

The following description of the geology of possible petroleum-producing formations in Humboldt County is from a press-release of the U. S. Geological Survey:

Natural seepages of oil and gas in southwestern Humboldt County attracted prospectors to northwestern California as early as 1860-1865, when the State was having its first excitement over the possibilities of developing valuable supplies of petroleum. Since that time a number of unusually productive oil fields have been found in California, but all of them are in the southern two-fifths of the State, no commercial production having been obtained in Humboldt County. The area of oil and gas seepages, as well as adjoining districts, in this county was examined briefly during the summer of 1926 by H. W. Hoots, a geologist of the U. S. Geological Survey.

The seepages and showings of oil and gas in wells are in the southwestern part of the county, within the drainage basins of Mattole and Bear rivers. There is also an isolated area farther southeast in the vicinity of Briceland. The rocks within and near these areas of seepage are chiefly of Mesozoic age, though late Tertiary rocks occur in parts of the region, notably along and near Eel and Bear rivers.

Character of Mesozoic Rocks.

The rocks at and near the oil and gas seepages along Mattole and Bear rivers consist in the main of sandstone, shale and conglomerate; associated with these are comparatively small amounts of hard red, gray and black foraminiferal limestone, black radiolarian chert, and igneous rocks in the form of basaltic intrusions and pyroclastic rocks.

This group of rocks is probably all of Mesozoic age and is believed to be equivalent to some part of the Knoxville, Horsetown, and Chico formations, of Lower and Upper Cretaceous age; strata equivalent to the Jurassic(?) Franciscan formation also may be present. The entire group of Mesozoic rocks is probably of marine origin and has been divided into three formations. (1) What appears to be the oldest formation is exposed on the coast near Spanish Creek and is characterized by a very hard, thinly bedded series of black shale, black limestone, and fine gray sandstone. (2) Next in age is a well-bedded succession of alternating gray sandstone and black shale in beds 1 to 4 feet thick, which outcrops on King Peak and in upper Honeydew Creek and apparently grades stratigraphically into the oldest and youngest formations. (3) The youngest series of rocks is characterized by massive ledges of hard greenish-gray sandstone, which are associated with much black and bluish-gray shale, a few hundred feet of black radiolarian chert, and irregular bodies of red and gray foraminiferal limestone and basalt. Although most of the rocks grouped under this series are probably younger than those of the two preceding formations, some of them may represent faulted masses of older rocks. This series outcrops over most of southwestern Humboldt County south of Bear River Ridge and yields all of the seepages and showings of oil and gas that have been obtained. The first two formations described are each about 4000 feet thick, but the thickness of the third is unknown.

Structure of Mesozoic Rocks.

The rocks in the areas of oil and gas seepages, from Bear River Ridge south to the coast, have been subjected during several periods to deformation, by which the strata have been intensely folded and faulted. Throughout practically the entire area they strike in northwesterly and westerly directions, approximately parallel to the courses of Mattole and Bear rivers, and the beds stand in a vertical position.

Much of the succession of vertical rock strata appears to be repeated at fairly regular intervals in directions across the regional strike of the beds—a relation which strongly suggests that the structure consists essentially of a series of vertical closed folds or of strike faults, or, more probably, a combination of both folds and faults. The tops of the folds, if any are present, have been removed by long-continued erosion, and, owing to the uniformly vertical attitude and fairly uniform character of the strata, axes of the folds are, as a rule, not apparent in the exposed rocks; and even though their location were determined, the axes of such sharp folds would probably be of little economic importance with reference to oil and gas.

In several areas in different parts of the Mattole River district the regional strike of the vertical beds toward the northwest and west is abruptly interrupted by similarly vertical strata which strike north or northeast—a relation which apparently is due to the presence of cross faults. The cross faults and associated strike faults seem to have broken this region of vertical strata into a series of fault blocks. There is, in fact, a strong suggestion that much of the zigzag coast line of southwestern Humboldt County has resulted from a series of intersecting northwesterly and north-northeasterly faults.

Explorations for Oil and Gas in the Area of Seepages.

One of the first wells to be drilled in southwestern Humboldt County was the Union well, drilled in 1865 by Leland Stanford and associates (Mattole Petroleum Co.) on the south bank of the lower North Fork of Mattole River in Sec. 30, T. 1 S., R. 1 W. This well is said to have reached a depth of about 1000 ft. and to have produced by pumping about 100 barrels of oil at the rate of one barrel a day. This well, when visited by Mr. Hoots in September, 1926, was found to have oil standing within 20 ft. of the surface.

About 25 wells, most of them less than 1000 ft. in depth, were drilled in the Mattole country and also along Bear River and Oil Creek during the years 1865-1867, but according to reports the old Union well produced more oil than any of the others. The available records indicate that up to the present 46 wells have been drilled for oil and gas in southwestern Humboldt County, most of which are reported to have obtained shows of oil or gas in varying amounts.

The most encouraging results during recent years have been obtained by the North Counties Oil Co. in its Etter No. 1 well on Mattole River near Honeydew, in Sec. 36, T. 2 S., R. 1 W. This is the deepest well drilled in the Mattole country prior to 1928. In

August, 1921, oil from a depth of 1920 ft. in this well is reported to have risen 510 ft. in the 8¼-inch casing and to have been accompanied by a very strong flow of gas; continued bailing for five years failed to lower the oil level, but attempts to increase production by drilling deeper were unsuccessful and resulted in a partial loss of the oil flow already obtained. (Additional notes on this well below.)

The oil found in southwestern Humboldt County is of paraffin base and ranges in color from dark green to amber. Fresh oil bailed from the North Counties Oil Co. Etter No. 1 well had a gravity of 45.7° Baumé and contained 60 per cent of gasoline and less than 1.0 per cent of sulphur.

Gas collected from the seepage on the south bank of Bear River near the bridge at Capetown contained 95.6 per cent methane, 4.1 per cent of ethane, and 0.30 per cent of nitrogen. For 35 years this seepage, according to the owner, has supplied sufficient gas to run a cook stove and water heater in a nearby farmhouse.

Gas from a well drilled at Briceland in 1892 was being utilized in September, 1926, for lighting the local hotel and store. It is said that this well during its entire history furnished sufficient gas for six or eight buildings.

Possibility of Commercial Production in Area of Seepages.

The widespread vertical dips and faults in the Mattole and Bear River districts are not regarded as favorable for the accumulation of large bodies of oil. The results that have been obtained by some of the wells in this district indicated that the oil and gas are locally trapped and prevented from escape along the vertical or nearly vertical strata. Exposed structural conditions near some af the most encouraging wells, especially that of the North Counties Oil Co. strongly suggest that at least some of these accumulations of oil and gas are in localities that have been broken by a system of faults. It seems probable that these faults have combined to produce suitable conditions for the accumulation and retention of oil and gas locally, but it is uncertain that such local deposits, when tapped by the drill, will yield oil and gas in commercial quantities. In view of the encouraging results obtained by some wells, the district can not be condemned, for it is conceivable that wells drilled in intrically faulted areas within this district may produce small quantities of oil and gas for a considerable period. However, owing to the structural conditions, even if production is obtained in one well, each subsequent well drilled must be considered a wildcat well with much chance of failure.

Character of Late Tertiary Rocks

Sedimentary rocks of late Tertiary age crop out in a comparatively broad belt in the hills adjoining both sides of the lower Eel River valley, in a narrow strip along Bear River, and in isolated patches south of Bear River and farther southeast near Briceland.

Most of these rocks belong to the Wildcat series of Lawson, chiefly of Pliocene age, and consist of 7000 to 11,000 ft. of conformable beds of soft light-gray and brown shale and sandstone. These strata are well exposed in the hills south of Ferndale, where the entire series has been divided into two distinct units—(1) a lower unit, consisting of 5500 to 7500 ft. of alternating beds of soft light bluish-gray and brown clay-shale and fine-grained sandstone, all of which contains considerable glauconite and an abundance of fossils, including Foraminifera; and (2) an upper unit, 2500 to 3000 ft. thick, which is composed of soft, well-sorted light-brown fossiliferous, massively bedded sandstone that becomes a conglomerate near the top.

Clay shale along the lower part of Bear River, west of Capetown, is equivalent to a part of the lower unit of the Pliocene, but more steeply dipping beds of similar character farther east along Bear River are shown by the contained Foraminifera to be older, probably of Miocene age.

In the vicinity of Briceland light-gray diatomaceous shale is associated with bluish-gray clay-shale which contains Foraminifera strongly indicative of Miocene age.

Structure of the Late Tertiary Rocks.

The late Tertiary rocks of Bear River and along Eel River valley are folded into pronounced synclines. The Bear River syncline extends from a point on the coast half a mile south of the mouth of Bear River eastward to Capetown and probably beyond, although at Capetown and farther east the beds are broken by faults and have very steep dips.

The Eel River syncline, the major fold of the region, trends in a northwesterly direction, approximately parallel to the lower courses of Eel and Van Dusen rivers. This fold, like the Bear River syncline west of Capetown, plunges west-northwestward, toward the ocean, and has a more steeply dipping northeast limb.

The late Tertiary rocks of these areas appear to occupy dropped fault blocks, which have acquired present position as a result of deformation since the Pliocene series was deposited. Post-Pliocene block faulting, accompanied by folding of the Tertiary rocks, is therefore believed to be largely if not entirely the agency determining the present distribution and structure of the Tertiary rocks of this region.

These younger rocks are, as a rule, strikingly less deformed and altered than the much older Mesozoic beds, and it is apparent that the relatively gently dipping Tertiary strata rest unconformably upon vertical or nearly vertical Mesozoic strata.

Possibility of Commercial Production from Late Tertiary Rocks.

No important seepages of oil and gas are known in the late Tertiary rocks of the Eel River valley. Although these rocks contain scattered calcareous, siliceous, and chitinous remains of marine plants and animals, which may have been the source for a small quantity of hydrocarbons, most of the late Tertiary rock section of this region consists of light bluish-gray clay-shale and sandstone that contain only small amounts of organic matter and are devoid of the dark color and other characteristics of rocks which are commonly considered as probable source beds for petroleum. Light-gray and brown diatomaceous shale, which is so common in the oil fields of California and is accepted by some geologists as the source rock for much of California's oil, does not appear to form more than a very small part of the Pliocene and Miocene rocks of Humboldt County. Small amounts of diatomaceous shale occur near Briceland and in the lower part of the Pliocene south of Ferndale. The absence of seepages and the scarcity of source material in the Tertiary rocks of this region force the conclusion that there is little indication that these rocks have themselves served as a source for an appreciable amount of oil and gas.

Other conditions, however, may be favorable to the occurrence of commercial deposits of oil and gas in these Tertiary strata. This thick series of beds rests unconformably upon the eroded surface of much older Mesozoic rocks which are known to contain numerous seepages of high-grade oil and gas south of the Eel River valley, in the area drained by the Mattole and Bear rivers. It is readily conceivable that considerable quantities of oil and gas may have originated in these older beds and seeped across the unconformity into overlying porous beds of the late Tertiary succession, where, if structural conditions were favorable for large-scale accumulation, oil and gas in commercial quantities might be expected. Thus it seems barely possible that oil or gas has accumulated in the subsurface beds of the lower part of the Pliocene which abut against the Bunkerhill fault along the north side of Bear River Ridge.

Strong shows of methane gas have been encountered and small shows of oil have been reported during the drilling of the Eureka Oil Company's Duff No. 1 well, five miles south of Eureka, at depths of 1900 to 2500 ft., in rocks that are apparently Tertiary. As no seepages are known in this district, the findings by this well are the only known indications of oil and gas in the late Tertiary rocks of the Eel River valley. (See also The Texas Company above.)

Structural conditions that can be unreservedly regarded as favorable for the accumulation of economic deposits of petroleum are not known to exist in any part of the area examined. Favorable anticlinal folds may be present, however, in the strip of hills northeast of Eel River and beneath the floor of the lower Eel River valley, where, if present, such folds are partly or completely concealed beneath a surface deposit of alluvium. Along the coast north of the mouth of Eel River the structure of the Pliocene rocks is partly obscured by a veneer of Quaternary clay and sand.

Summary.

In view of the geologic structure of southwestern Humboldt County, prospects for the development of large quantities of oil and gas in the region south and southwest of Eel River are not promising. Showings obtained by wells already drilled, however, prove conclusively that small accumulations of high-grade oil and gas exist in the older Mesozoic rocks south of Bear River Ridge, and indicate that production on a small scale may be possible. Because of complex structural conditions, exploitation of small deposits of oil in this district will probably be expensive, but it is by no means beyond the bounds of possibility that the Mattole country may, in years to come, yield enough oil from a series of shallow wells to be of some importance.

Oil may exist in the late Tertiary rocks in the vicinity of Eel River, but the absence of seepages and other indications in the exposed strata of this district is not encouraging. Structural conditions in Tertiary rocks south of the lower Eel River do not warrant drilling for oil at the present time, although there appear to be possibilities for accumulations of oil and gas along the Mesozoic-Tertiary unconformity, against faults, and in possible folds in different parts of the Eel River-Elk River district. (P.N. 21122)

Cape Mendocino Oil Company. Notes on Walker No. 2 well of this company on Joel Flat, in Sec. 15, T. 1 S., R. 2 W., are furnished through the courtesy of W. O. Kinsman of Eureka as follows: The well was drilled recently from a depth of 1810 ft. to 2026 ft. Junk in the hole caused trouble, and the well had to be redrilled in part a number of times. Electric logging did not show favorable indications below a depth of 2021 ft. The lower part of the hole was plugged, and a test was run on the oil-zone for some time. The well failed to show commercial production and was abandoned in November, 1939.

North Counties Oil Company has been drilling on the Etter Ranch, Honeydew, in Sec. 36, T. 2 S., R. 1 W. E. C. Matthews is president, and W. O. Kinsman is secretary, 520 F Street, Eureka.

Well No. 1 went through sand and sandy shale showing oil and gas from a depth of 1873 ft. to 1883 ft. and from 1894 ft. to 1920 ft., according to Matthews and Kinsman. The well was shut down for four days, at a depth of 1920 ft., to wait for a control-head. During this time, it is said that oil rose 510 ft. in the 8¼-inch casing and that a production of 168 barrels per day did not lower the oil in the hole. Drilling was continued to a depth of 2310 ft., but then the casing collapsed, and the well was abandoned. Similar trouble developed in well No. 2 at a depth of 2205 ft.

Well No. 3 has recently been drilled to a depth of 2315 ft. according to Matthews and Kinsman. They state that a heavy flow of gas accompanied by oil was encountered, which necessitated shutting down until arrangements could be made to put on a full crew and drill for 24 hours per day. This is necessary because of the increasing gas-pressure. Just before the well was shut down, a hard limestone stratum was penetrated. In the fall of 1940, officials of the company expected to resume operations shortly.

Oil developed is in Mesozoic rocks and is of paraffin base. Fresh oil bailed from Etter No. 1 well had a gravity of 45.7° Baume and contained 60 per cent of gasoline and less than 1.0 per cent of sulphur.

Bibl: State Mineralogist's Reports VII, pp. 195-200; VIII, p. 216; X, p. 207; XI, pp. 227-232; XIV, pp. 410-414; Bull. 19, pp. 161-166; Bull. 69, pp. 444-454; Bull. 89, pp. 40-43.

PLATINUM.

Small amounts of platinum metals are produced as a byproduct of placer mining for gold. Further details are contained in Bulletin 85 of this division.[1]

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[1] Logan, C. A., Platinum and allied metals in California, State Division of Mines Bull. 85.

QUICKSILVER.

Prospects of cinnabar have been reported from the Mill Creek district south of Orleans and from the top of the ridge which continues to the north from the line between T. 6 N., R. 3 E. and T. 6 N., R. 4 E. No quicksilver production has been reported from Humboldt County.

SAND, GRAVEL, AND CRUSHED ROCK.

Hemstreet & Bell, 411 C Street, Marysville, have recently produced sand, gravel, and crushed rock at Garberville. The plant has not been visited.

Hull, Tom, 930 Carson Street, Eureka, excavates sand and gravel from the bed of Mad River, Sec. 15, T. 6 N., R. 1 E., with a slack-line excavator and bucket of a capacity of one cubic yard. The plant is four miles west of the town of Blue Lake. Gravel is crushed and screened so that products from 2½-inch down to fine sand are prepared for the market. Ten or twelve different sizes can be made by changing screens. The material is washed with water pumped from Mad River. Capacity is 250 cubic yards in 8 hours. The slack-line excavator is powered by an automobile engine; the crushing and screening plant by a 40-hp. Caterpillar gasoline engine, and the pump by an electric motor. The plant is run intermittently. Stock-piles of several sizes are kept on hand.

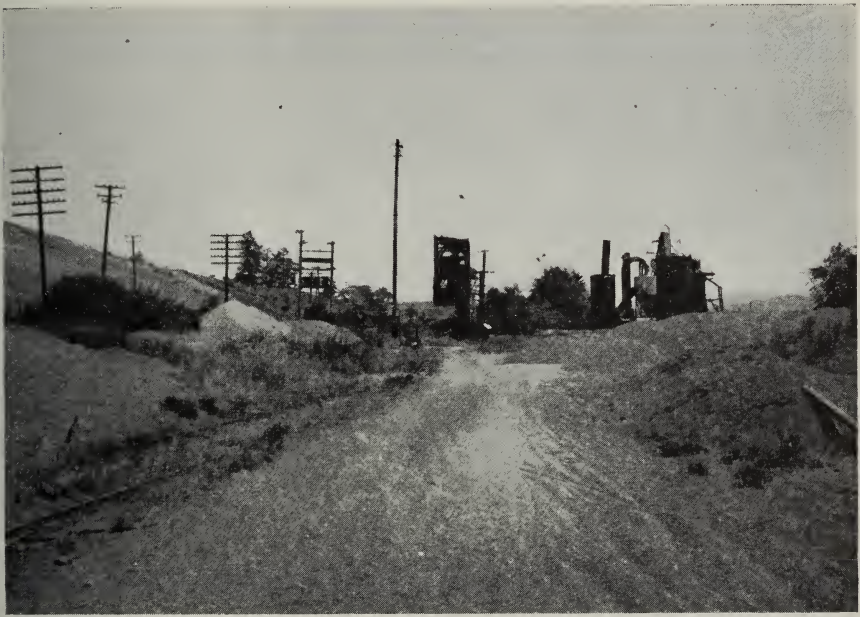

FIG. 7. Mercer Fraser Company, Worswick plant.

Mercer Fraser Company, Hugh Graham, manager, 2nd and Commercial Streets, Eureka, operates two plants for the production of sand, gravel, and crushed rock. One is at Worswick, Sec. 28, T. 3 N., R. 1 W., and gravel is excavated from bars on Eel River. The other is at Essex, Sec. 14, T. 6 N., R. 1 E., and gravel is obtained from Mad River. Both plants are on railroads; also on State highways.

At Worswick, three-quarters of a mile southeast of Fernbridge, the company operates a slack-line excavator with bucket of 1½-cu. yd. capacity to deliver sand and gravel from Eel River to a crushing and screening plant of a capacity of 200 cu. yd. in 8 hours. Capacity of excavator if no crushing and screening are done is 350 cu. yd. in 8 hr. Crushing is to 1½-inch size and less. This plant includes also apparatus and machinery for mixing sand and gravel with hot asphaltic oil at the rate of 400 tons in 8 hours, for paving.

The crushing and screening plant at Essex on Mad River is of half the capacity of the one at Worswick, being equipped with a bucket of three-quarters of a yard in capacity. The company owns also the quarry at Trinidad where basaltic rock was formerly produced for jetty construction. Equipment has been removed but a stock of crushed rock in certain sizes is still on hand.

Bibl: State Mineralogist's Report XXI, pp. 323-324.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

In this Issue

Mr. Edwin B. Eckel has very kindly prepared a statement as to what the United States Geological Survey has done as regards the examination of quicksilver deposits in California. We hope to get similar statements on the Survey's work on manganese, chromite, and tungsten.

In this issue of the Journal is a report on ''Tin in California,'' which covers the whole subject of the industry, and the mineralogy, uses, geology, and ore-dressing of tin. The paper was prepared by Richard J. Segerstrom (now metallurgist in Sonora) as a student working under the direction of Charles A. Dobbel, professor of mining at Stanford University, and in cooperation with the Geologic Branch. Since this report was written, the United States Geological Survey has made field investigations of most of the tin occurrences in the United States, and the results of this work will undoubtedly be made available in special publications.

Because known tin deposits in the United States are of extremely limited extent, the occurrences in California are especially noteworthy. With the author's description of how cassiterite is found in nature, and how one may adequately test this mineral, perhaps new discoveries will be forthcoming. Many of the older reported occurrences of tin can not now be proved and these are shown on the accompanying index map as occurrences which are ''not substantiated.''

In Press

Parts Three and Four, ''Descriptions of Individual Oil and Gas Fields'' and ''Glossaries, Bibliography, and Index,'' respectively, of Bulletin 118, ''Geologic Formations and Economic Development of the Oil and Gas Fields of California,'' are now in press. Final publication of these parts as one pre-print volume, will, it is hoped, be sometime before the summer of 1942. A State map of the oil and gas fields, drilled areas in the State, and other data, is to be folded and put in a pocket in Part Four. This map will also be sold separately. It will be available shortly.

TIN IN CALIFORNIA *

By Richard J. Segerstrom **

OUTLINE OF REPORT

Page
ABSTRACT 531
INTRODUCTION 532
  Purpose and scope 532
  History of California tin 533
THE TIN SITUATION IN THE UNITED STATES 534
  Present and future 534
  Government policy 536
  Development of substitutes 536
ECONOMICS OF TIN 536
  Uses of tin 536
    Tin plate 536
    Pure tin metal 537
  Tin alloys 537
    Bronzes 538
    White alloys 539
    Solder 540
    Die-casting alloys 540
    Low-temperature-melting-point alloys 540
    Pewter 541
    Terneplate 541
  Chemical compounds 541
  History of the uses of tin 542
  Production of tin in California 543
  Tariff history 543
  Future of tin mining in California 544
MINERALOGY OF TIN 544
  Tin minerals 544
  Field determination of tin 545
GEOLOGY OF TIN 545
  Occurrence of tin 545
  Origin of tin ore 546
  Ore-finding geology 546
TIN ORE DRESSING 547
  Concentration of tin ores 547
  Common treatments of complex ores 547
    Calcining roast plus mechanical separation 547
    Leaching 548
    Sintering 548
    Flotation 548
  Typical gravity concentration of tin ore 549
SUMMARY OF RECORDED TIN OCCURRENCES IN CALIFORNIA 550
BIBLIOGRAPHY 553

ABSTRACT

This report represents a correlation of existing records of tin occurrences in California, as well as the results of personal investigations of the nature and state of the tin industry. Personal visits were made by the author to many of the tin occurrences of the State, to aid in the preparation of this report.

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* Prepared under the direction of Professor Charles A. Dobbel, Mining Department, Stanford University. Manuscript submitted for publication June 1941.

** Research Division, Nevada-Massachusetts Co., Sonora, California.

After an extended analysis of the situation of tin in California was made, the following conclusions were reached:

(1) Tin is very important to the United States, and over 99 per cent of the supply for domestic use is imported.

(2) Although tin has been produced in California, there is no indication that any important amount will be forthcoming in the future.

(3) The known occurrences of tin in California are little more than geologic curiosities at present.

(4) There are no encouraging tin prospects in the State at the present time.

(5) A tremendous stockpile of the metal is our best protection against shortages.

(6) A high import tariff would not substantially increase domestic production, because marginal deposits are lacking.

(7) Tin minerals are not easily identified in low-grade ores; this fact explains the lack of new discovery and the numerous disputed discoveries.

(8) With modern ore-dressing methods, the cost of milling tin ore from domestic sources should not be prohibitive.

(9) The geologic age and the acid-constituent content of the granitic intrusives in California do not appear favorable for the occurrence of large amounts of tin.

(10) The fact that tin is not recovered from gold placers of the State demonstates that no appreciable amounts of tin are present in those regions.

(11) There seems to be no favorable future in the Riverside County deposits, which are the largest in the State at present known.

INTRODUCTION

PURPOSE AND SCOPE

Although it has long been recognized that tin has an important part in the life of every American and that the United States produces only negligible amounts of this metal, importing practically all the domestic supply, no coordinated surveys of tin deposits, developed or undeveloped, in this country have been made to date. The present threat of interruption of all imported tin supplies because of world conditions has increased the importance of any possible domestic source of tin. The United States Geological Survey is at present examining various tin properties—this being the first instance of any practical examination of tin properties by government agencies in some fifty years.

California is one of the six states in this country that have produced any tin commercially. The present report is an attempt to make as systematic a survey as possible of all tin occurrences noted in California, and to summarize other information on tin.

The Report of the House Subcommittee on Foreign Affairs, ''Tin Investigation'' (1935), deals with tin from a national viewpoint, and various details from this Government investigation are quoted herein.

''Tin,'' by C. L. Mantell, also quoted in this report, deals mainly with details of the chemistry and metallurgy of tin.

HISTORY OF CALIFORNIA TIN

The history of California's tin is not as impressive as that of its gold or quicksilver; it appears that no tin-mining enterprise has operated successfully in this State.

Tin was discovered in the Temescal (San Jacinto) region of Riverside County in southern California. There seems to be some question as to the date, however. Hanks (84, page 120) gives the year as 1853; Cronise (68) as 1854; and Bancroft (90) as 1856; while J. W. Furness (28, page 68) states:

> "The first discovery of tin in what is now the United States was made in southern California in 1840. Cassiterite was found on the property then known as El Rancho Sobrante de San Jacinto, in San Bernardino County."

Work was interrupted by the Civil War in 1861 and was necessarily suspended until 1868, when it was resumed by the San Jacinto Tin Mining Company. With American capital, the company acquired the Rancho Sobrante de San Jacinto, a Spanish grant of 49,000 acres. The work was confined to what is known as the Cajalco lode, situated near the center of an extensive vein system, and was devoted principally to development. Apparently insufficient ore was found and work was suspended, no attempts at ore treatment being made.

In 1889, the San Jacinto Tin Mining Company was financed in London, and work was resumed on the property. This company originally intended to cross-cut the entire vein system of this region with an adit, giving in places 1,000-foot backs, the adit to be started in a canyon 2 miles from the already developed Cajalco lode. A mill of about 100 tons per day capacity was to be situated near the mouth of the adit.

Waterpower for the reduction works was to come from a reservoir about a mile up the canyon, where the water was to be impounded by a suitable dam. This work was started with the capital of some $100,000, and the dam and mill were only partially completed when the project had to be abandoned because of the lack of funds. With fresh capital and new management, a new start was made and the mill and reduction plant were erected near the main Cajalco mine.

In the year 1890, a small experimental five-stamp mill was erected at the mine, and also a small reverberatory furnace designed to be fired with crude petroleum. At the end of the year, the mine was producing 20 to 25 tons a day, and, due to increased reserves, stamps were added; early in 1891 the output was from 40 to 50 tons of crushed ore per day. Apparently at this time, when everything was looking bright, the ore suddenly bottomed at approximately the 300-foot level. The lode was of considerable width at this point but was found to contain no tin. Under a third management work was suspended in 1892. Fifty tons of metallic tin were produced each year of operation, the production of the second year apparently being from ore on hand or developed in the previous year. The total production amounted to about $60,000. Thus ended the first actual tin production in California.

The later history of the Temescal deposit has been far from encouraging. The American Tin Corporation spent some money on the property and produced about half a ton of tin in 1928 and 1929. Apparently this last venture was entirely unsuccessful. Though there are other purported tin mines in California, Temescal is apparently the only one which produced tin in any appreciable quantity.

In 1916 a 50-ton plant was erected in Trabuco Canyon in Orange County, to treat tin ore. No record of any actual production exists, and although the mill building still stands, it is apparent that the venture was not successful. This plant and the Cajalco plant are the only ones built in California for the definite purpose of treating tin ore.

Other deposits of tin have been reported in California, but apparently none has warranted the installation of a plant.

THE TIN SITUATION IN THE UNITED STATES

PRESENT AND FUTURE

On February 17, 1941, Jesse Jones, Secretary of Commerce and chairman of the Reconstruction Finance Corporation, issued the following statements:

Necessary Tin in the United States:	
Peacetime Consumption	75,000 tons per year
Wartime	90,000 to 100,000 tons per year
U. S. Stocks at this Date	
Private Industry	93,000 tons
Government Stockpile	19,000 tons
En route to Government Stockpile	18,000 tons
Total	130,000 tons
Tin "On Order"	
From Bolivia	18,000 tons per year
From Far East	64,000 tons per year
Time Present Supply Will Last	1 year 5 months

The 18,000 tons of tin per year that Bolivia is under contract to furnish is ore, and must be smelted. Since there are as yet no smelters in the United States,[1] and since shipment to Britain where it was formerly smelted is wasteful of limited cargo space and convoy service, little good can be realized from this source until a domestic tin-smelting industry is established. The Far Eastern tin, although in the metallic state, would probably be cut off from shipment to this country in time of war. Our domestic source of tin is nil; our waste of tin is stupendous.

With the possibility of war, and with the consequent possibility of complete stoppage of tin imports, drastic changes in the administration of the use of tin will soon be needed.

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[1] According to Pehrson and Umhau (41, page 674) "Tin ores are now treated on a small scale by several plants in this country. In 1940 these plants produced 1,746 long tons of tin, including 510 tons in the form of pig tin and 1,236 tons in the form of alloys (mostly solder) made direct from the ores. The ores treated in 1940 were obtained chiefly from Latin American countries, principally Bolivia, although small quantities produced by domestic mines were also purchased. Companies reporting the recovery of tin from ores in 1940 included Phelps Dodge Corporation, American Smelting & Refining Co., Nassau Smelting & Refining Co., Kansas City Smelting Co., Metal & Thermit Corporation, and Vulcan Detinning Co."

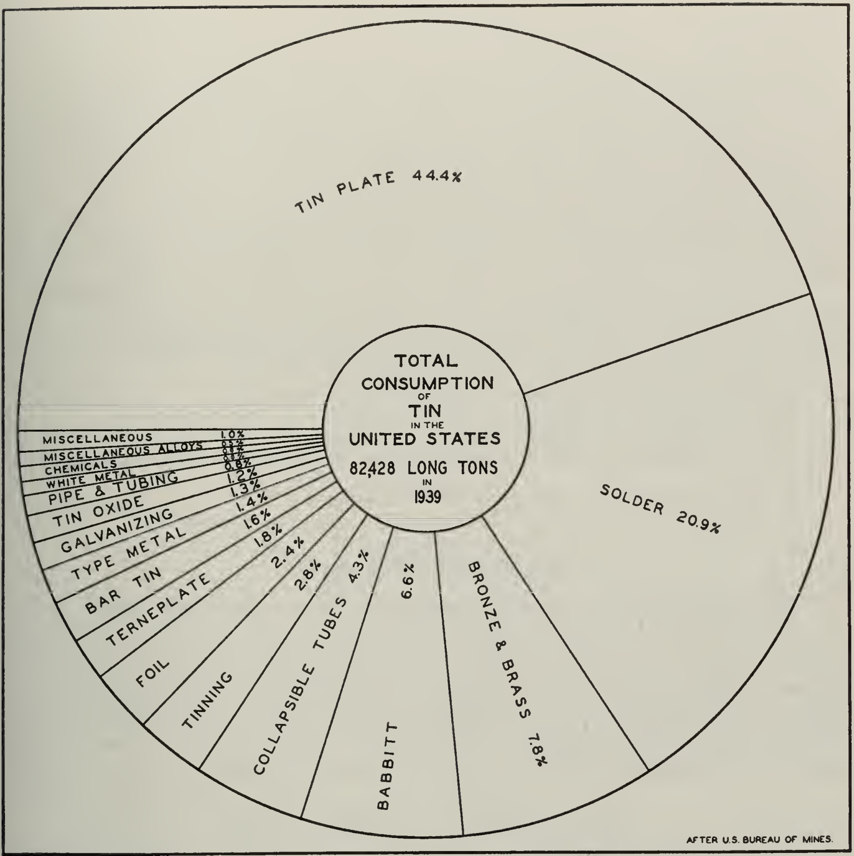


FIG. 1. Diagram showing total consumption by uses of tin in the United States, for the year 1939.

The following list gives tin consumption reduced to a minimum for wartime use:

	Tons
Tin Plate	20,000
Electrical	20,000
Bearings	12,000
Miscellaneous	8,000
Total	60,000

The following changes will have to come about if we are to reduce the likelihood of a tin starvation:

(1) Tin cans will have to be eliminated in favor of other coated steel or glass containers. Tin cans will only be used for supplying foods to the fighting forces.

(2) Solder will only be used where no practical welded joint can be made and only in prime electrical industries.

(3) Means will have to be taken to recover tin from all possible sources.

(4) Tin as a weighting agent, abrasive, and in other uses will have to be eliminated.

(5) Roller and ball bearings will necessarily replace bronze bearings in every possible instance.

(6) Smelting of hemispherical ores will have to be started on a large scale.

(7) All possible producing mines in this country will have to be worked.

(8) Research into tin substitutes will have to be launched on a large scale.

(9) Export of tin scrap of any nature must stop.

(10) The general public must be informed of a shortage of tin and tin products.

On the other hand, we have the following facts to face:

(1) Canned foods represent a chief source of nutrition to our people, especially those with small incomes.

(2) Shortage of solder may prevent minor repairs resulting in eventual breakdown of non-defense equipment.

(3) The cost of collection and recovery of tin from waste would be high and the training of men to work in this industry would require much time.

(4) The manufacture of silks and chemicals requires tin.

(5) The production capacity for steel bearings is limited.

(6) Tin smelting is difficult to start immediately in this hemisphere.

(7) No development of tin mines in this country has been made.

(8) Government funds for tin-substitute investigation will not be easily obtained.

(9) Foreign trade can not be stopped altogether.

(10) Public curtailment does not always meet with full cooperation.

GOVERNMENT POLICY

The acquisition of a government or private stockpile of tin is not to be looked upon as a poor investment in any case. We provide no tin, so mining operations will not be affected by a reserve when the present crisis is over. The major difficulty lies in acquiring a stockpile of a metal which can hardly be produced fast enough for its market. Immediate action in acquiring a stockpile is necessary since every day brings us nearer the point of import stoppage.

DEVELOPMENT OF SUBSTITUTES

It has been recommended many times that government funds be appropriated for research in the development of tin substitutes, but no such appropriations have been granted. It is unfortunate that such circumstances have prevailed in this country up to the present time, but the future will no doubt see the development of some substitutes for tin.

ECONOMICS OF TIN

USES OF TIN

Tin is imported into the United States in the metallic form and this will continue until smelting is done here.

Tin Plate

Tin coated on thin sheet steel is termed ''tin plate'' in the industry. It is the principal consumer of pure tin, taking approximately 43 per cent of the entire amount of the imported metal. This product has a tremendous number of uses. The greatest use is, of course, in the ''tin can,'' which actually contains less than 2 per cent of tin. Tin-coated containers are extremely useful in the modern way of living. They not only give a pleasing appearance, but are durable as well.

The steel used in tin-plate manufacture is made under accurately controlled conditions and must be of a specific quality. It is usually a low-carbon variety and is accurately rolled into sheets in the steel mills. The principal thickness of steel used in the tin-plate industry is between 30 and 34 gage (U.S.S.G.), or between 0.5000 and 0.3437 pounds per square foot.

The sheet steel is first pickled in sulfuric acid in order to remove scale, and is then annealed to remove rolling strains and gases absorbed in pickling. It is again rolled to improve the surface structure, and then treated to a second acid bath for a final cleaning preparatory to immersion in the molten tin.

The tinning bath temperature is controlled within narrow limits as the temperature greatly affects the quality of the resultant tin plate. Floating on top of the molten tin is a layer of flux which cleans the steel sheet as it passes into the tin bath. Following tinning, the plate is polished to remove oil which has been applied to prevent oxidation. Then the lustrous plate is ready for the container factory.

Pure Tin Metal

Pure tin metal, where used, must be of an extremely high quality (well over 99 per cent Sn) if full advantage is to be taken of its physical qualities. It is generally marketed on the basis of its purity, and all quoted market prices for tin include a stipulation as to the purity of the product.

About 9 per cent of the tin consumed in the United States remains in its original pure form. Very little of this tin, however, is recovered for re-use. The greatest amount of the pure metal is used in collapsible tube containers for toothpaste, shaving cream, and the like. Lesser amounts are used for foil and tubing.

Collapsible tubes are made by striking a disc of tin, placed in a die, a sudden blow by a cylindrical tool which, while forcing a major portion of the tin to the end of the die to form the shoulder and nozzle of the tube, produces the thin walls.

Extruded tin pipe finds a variety of uses in a great number of industries where conveyance of water, milk, or beer without contamination is desired.

The foregoing uses of tin depend on the corrosion-resistant qualities of the metal in the pure state. Tin is not entirely resistant to various solvents, but it is nonpoisonous in normal compounds.

TIN ALLOYS

> "Tin readily forms alloys with most of the other metals. Some of the alloys are of great commercial and industrial value, and the use of tin in alloys is second in importance only to its use as tin plate." (Liddell, D. M. 26, p. 1368)

Mixing of tin with other metals has long been practiced; bronzes made about 3500 B.C. contain sufficient tin to place them in a class of alloys used today. The use of tin in alloys has made it of great importance in many industries.

The alloys of tin are generally placed in two classes: (1) alloys of copper, termed bronzes; and (2) the white metals—alloys with lead, antimony, bismuth, and small amounts of copper.

Bronzes

The ancient bronzes were probably made by adding tin ore and reducing agent to molten metallic copper. The tin mines of Cornwall and other countries were important for this reason, and the possession of these sources was of tremendous economic value. The first bronzes were probably discovered quite by accident, but their importance to civilization has been tremendous and has been the subject of much scientific research.

Bronze is principally an alloy of copper and tin. Lead, zinc, and phosphorous are useful as agents in developing particular properties in the bronze alloy. Zinc is added to make the molten alloy more fluid, but its addition reduces corrosion resistance. Phosphorous produces greater strength and hardness in bronze, but it is confined to less than 4 per cent of the total alloy weight. Lead is added to increase the plastic yielding in bronzes used in severe bearing service. Nickel, aluminum, manganese, and iron are found in some bronzes, but are restricted to particular cases. The use of manganese bronze in brazing has placed brazing in a class with actual welding due to the tremendous strength of this alloy.

The amount of tin used in bronzes varies from less than 1 per cent to a maximum of 40 per cent. The appearance of a second and harder constituent when the tin content is above 10 per cent is responsible for the great use of bronze in bearings. In order to be successful, a bearing metal must consist of hard particles as wearing surfaces surrounded by a groundmass of a soft material for support and shock resistance. The surface junction of the hard particles and the supporting material produces a maze of lines which act as oil ducts and insure proper lubrication of the bearing surfaces. Thus bronzes with a tin content of less than 10 per cent are unsuited to bearing service since the tin is completely soluble in the copper and freezes as a solid solution. This class of bronze is suited only for corrosion-resistant uses as in statuary, coins, and piping. A bronze with a tin content of less than 20 per cent and more than 10 per cent is classed as bearing material for reasons given above. This does not mean that all bronze bearings fall in this range, since the addition of a third or fourth element may alter the amount of tin used. Where the alloy contains more than 20 per cent, and begins to be composed of virtually all hard constituent, uses are restricted to bells and mirrors, since the hard constituent is responsible for good bell quality and also takes a high polish.

TABLE I (After Mantell)

(Liddell, D. M. 26)

COMPOSITION OF BRONZES

	Percent				
	Cu	Sn	Zn	Pb	Others
Aluminum Bronze	64.0	0.2	29.0		Al 3.1; Fe 1.2
Manganese Brass	60.15		34.76	0.39	Al 0.2; Fe 1.19
Hardware Bronze	88.0	1.50	9.50	1.0	
Tobin Bronze	60.0	2.0	38.0		
Coinage	95.0	4.0	1.0		
Steam-Fitting Bronze	88.0	8.0	2.0	2.0	
Gun Metal	90.0	10.0			
Gear Phosphor Bronze	85.0	13.0	2.0		P 0.1
Bell Metal	64.0	24.0	9.0		
Speculum Metal	67.0	33.0			

Brasses are principally alloys of copper and zinc, but tin is sometimes added to make the alloy less viscous in the fused state.

White Alloys

In reciprocating engines and other places where severe bearing-stress is involved, the bronze type of bearing is not plastic enough to withstand the strain. Softer types of bearings made of Babbitt metal are generally used in this service. Though Babbitt metal is but one type of white alloy, all bearing-metals that are silvery white in appearance have become known as ''Babbitt.''

White bearing alloys are composed principally of tin with a small amount of copper and antimony added. The same hard constituent that is used in bronze bearing alloys forms as the wearing surface in the Babbitt alloys. The tin groundmass or supporting structure is hardened by the addition of antimony, which remains in solid solution when in amounts of less than 8 per cent. Above this a hard tin-antimony constituent forms which is not successful as a bearing structure because of its tendency toward segregation.

The softness of the white alloys is ideal in the applications stated above, but they must be used as thin bearing surfaces, tenaciously clinging to a backing for support against distortion.

White metal alloys find a large application in the printing trade. About 2 per cent of the tin consumed in the United States is in this specific trade.

Two type-metal alloys are made; one, a hard alloy, is cast into ''hand set'' or hard type which is considered permanent; the other ''soft,'' less permanent alloy, is used in linotype machines. The former alloy, consisting of from 5 to 20 per cent tin, 24 to 30 per cent antimony, and the remainder lead, is very hard and wears slowly. The latter alloy is ''quick setting,'' solidifying rapidly in the molds. It has the composition 2.5 to 3 per cent tin, 10 per cent antimony, and 87 to 87.5 per cent lead. Being softer, it can be used only for a limited time, but it is remelted and used over again in the typesetting machine.

Solder

Solder is usually an alloy of tin and lead combined in various proportions. However, the following pertinent statement has been made:

> "Any alloy or metal that will readily alloy with other metals or alloys at ordinary soldering temperatures may be considered as a solder." (Mantell, C. L. 29, p. 175)

Therefore, it may be said that a lead-tin solder should be termed as such, and not as just "solder." However, in this discussion, "solder" will refer to an alloy of tin and lead, without further specific classification.

The lead-tin ratio in a solder is quite variable and depends on the use to which the solder is put. The eutectic ratio of tin to lead is 63:37, and this composition alloy is used where rapid solidification at a low temperature (181° C) is desired. The soldering of electric conductors is expedited with this type of solder. When solder is "wiped," or shaped in a pasty condition, a wide solidification range is necessary. This is obtained in an alloy of 65 per cent lead and 35 per cent tin. A solder of medium type (1:1) is used where general applications do not specify a particular type. It solidifies fairly rapidly and can also be wiped as described above.

Solder depends entirely upon the tin for its alloying or sticking qualities. Lead in the absence of tin will not adhere to brass or iron, but with the addition of a small percentage of tin, it immediately takes on this adhesive quality. Adhesion of a white metal alloy to its base is responsible for its success as a bearing material; and tin, not only responsible for a successful bearing, contributes this adhesive quality.

Adequate cleaning of a surface is necessary before successful soldering operations can be carried on, so fluxes of various types are generally used. When no flux is present, adherence is virtually impossible. Thus tin is used without flux in die casting, where non-adherence is necessary.

Die-casting Alloys

Die casting involves the injection, usually under pressure, of a low-temperature-melting-point alloy into a metal mold. The mold is usually water-cooled, so the alloy solidifies rapidly and can be removed. The absence of fluxes prevents adherence of the alloy to the mold to the shape of which it conforms with great accuracy. No machining is necessary on die castings as accuracies of plus or minus 0.0015 inch are usually obtainable. Threads can be die cast into the finished product and thin wall sections that could not be obtained in ordinary cast products are easily produced. The most intricate die casting is that of an automobile carburetor—an example of the exactness of the art.

Tin plays a minor role in die casting while lead and zinc, because of their relative cheapness, are the major constituents. Zinc-base alloys contain 2 to 10 per cent tin, and lead-base alloys contain up to 20 per cent.

Low-temperature-melting-point Alloys

Tin is a constituent of some low-temperature-melting-point alloys which are used as fusible plugs and links in automatic sprinkler systems. Melting points as low as 60°C have been attained in these alloys, a list of which can be found in Table II.

TABLE II

LOW-TEMPERATURE-MELTING-POINT ALLOYS

Fusion Temperature °C	Percent Bi	Percent Sn	Percent Pb	Percent Cd and Others	Originator
60	53.5	19	17	10.5 Hg	
60	50	13.3	26.7	10	Lipowitz
66–71	50	14	24	12	Wood
70–74	49.5	13.1	27.3	10.1	
93	50	25	25		
95	50	18.75	31.25		D'Arcet
96	52.5	15.5	32		
100	50	22	28		Rose
103	54	26		20	
145		50	32	18	

Pewter

The pewter of ancient Europe was an alloy of tin and lead of the approximate composition 90 per cent tin and 10 per cent lead. When it was found that lead in pewter could result in lead poisoning, especially when acid foods and beverages were served in containers fabricated of the alloy, the lead was replaced by antimony and copper in small percentages. These pewter alloys are in the same class as the white alloys previously discussed. Pewter metal is either cast into the required shape, or into ingots which are then fabricated into the required shape.

Terneplate

Terneplate is similar to tin plate in fabrication but not in use. In the preparation of terneplate, steel sheets are coated with an alloy of tin and lead. The use of terneplate is restricted to roofing materials, containers which do not come in contact with foodstuffs, and various special products such as automobile gasoline tanks.

CHEMICAL COMPOUNDS

Chemical compounds of tin used in industry are largely derived from the reclamation of tin from tin scrap. The product of tin scrap treatment is stannic chloride.

Stannic chloride is sold in crystalline form (hydrated stannic chloride), as the anhydrous liquid, or in solution. It has a wide variety of uses, the principal ones being as a weighting agent for silks and as a mordant in dyeing and printing. Less important uses are: in adhesives, as a weed killer, production of iridescent effects on glass, smoke screens, rust-removing agent, catalytic agent in oil refining, compounding agent in pharmaceuticals, and as a color brightener in textiles.

Tin dioxide or stannic oxide is also a much-used chemical compound of tin. It is made by heating very pure tin in the presence of large quantities of air, "burning" it to the pure white oxide. The ceramic industry consumes the largest portion of the tin oxide produced in the United States. It is used in opaque glasses and ceramics, particularly in the enamels placed on cast iron for sinks and bathtubs. The replacement of tin oxide by antimony oxide has been necessary because of the rising cost of tin. Stannic oxide is also used in polishing powders, special dentists' abrasives, and textile manufacture.

Stannous chloride ($SnCl_2$) has many of the same uses as stannic chloride. It is made by dissolving pure metallic tin in a measured amount of hydrochloric acid. The principal uses to which this salt is put are as follows: as a testing agent for arsenic; as a retarder of fermentation in the brewing industry; in the dye industry as a reducing agent; as an ink eradicator; in paint manufacture; as a bleaching agent for sugar; as a weighting agent for silks; and as a dyeing and printing mordant.

Other tin chemicals of lesser importance are stannous sulphate, used by the dyeing industry and in electroplating; stannous oxalate, used in textile industries; and stannous tartrate used in some instances to replace stannous oxalate.

HISTORY OF THE USES OF TIN

Tin was first used, before the dawn of history, in the bronzes of the Bronze Age, but was not known in its metallic state until several thousand years later. It appears that tin was originally smelted by the Egyptians, who were quite adept at the art, not later than 600 B.C. The original uses of the pure metal were strictly ornamental, and it was hand-beaten in China to a thin foil for coffin lace long before the Christian Era. The first practical uses of tin were in bronze vessels, statuary, and bells. The use of tin as a coating for other metals did not appear generally before the thirteenth century and was not a successful venture until 1720. The sheets of iron were made by hammering and therefore the thickness of the plate was far from uniform. In 1720 the rolling mill was introduced and the quality of tin plate produced was materially improved. The introduction of the steam engines to replace water power in 1770 allowed greater output from the industry. In 1874 attempts were first made to produce tin plate in the United States, but competition from abroad proved too great, and it was not until a tariff was placed on tin plate in 1890 that the American tin-plate industry became economic. Since 1890 the expansion of that industry in the United States has been tremendous and today the United States is far ahead of any other nation in tin-plate manufacture.

Tinning, or hand-dipping of objects in baths of molten tin, was the original method of producing tin plate; but today dipping is a continuous operation and hand-dipping is confined to such materials as hardware, and milk cans.

The use of tin in bearing materials has followed the machine age in its trends until today the metallurgy of bearing alloys is an exact science.

The collapsible tube, although invented in 1841 and first made of tin in 1850, was not generally used until the early nineteen hundreds. Today the collapsible tube uses 4 per cent of the entire amount of tin consumed.

PRODUCTION OF TIN IN CALIFORNIA

The production of tin in California was confined to two periods, one in 1891-1892 and another in 1928-1929. Production has not been great and has not resulted in profitable operation.

TABLE III

PRODUCTION OF TIN IN CALIFORNIA

From Cajalco Mine, Riverside County

Year	Long Tons	Value (Dollars)
1891	56.00	27,564
1892	56.20	32,400
1928–1929	0.54	580
Total	112.74	60,544

Considering that the annual consumption of tin in the United States is approximately 75,000 long tons, the production given in Table III is far from impressive.

Numerous prospects or purported prospects have been reported in California, but none have contributed in any way toward the State's tin production.

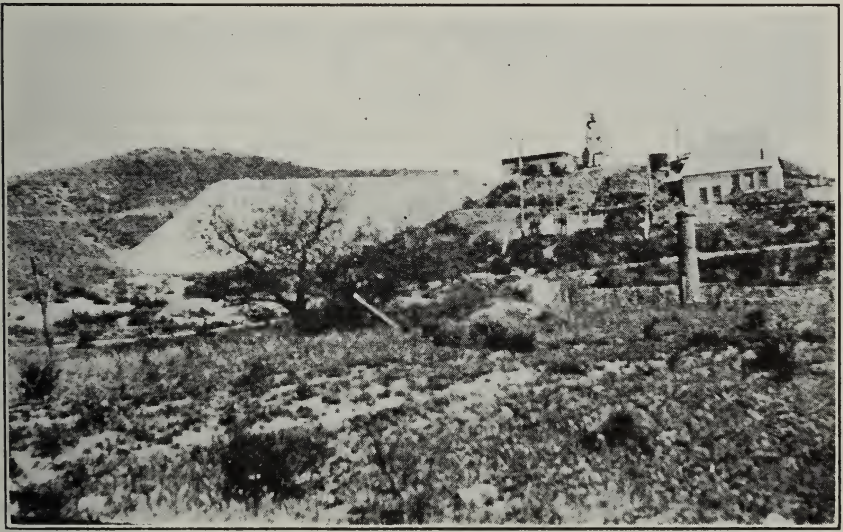


FIG. 2. No. 1 Shaft, Temescal Tin Mine, American Tin Corporation, Riverside County (Tucker and Sampson 29, page 497).

TARIFF HISTORY

There has been but one brief tariff imposed on tin imported into the United States. This duty of 4 cents per pound was placed on tin July 1, 1893, and was abolished August 28, 1894. Pure metallic tin is today allowed free entrance into the United States.

In 1922 a tariff was placed on tin ore entering the United States. This act placed a duty of 4 cents per pound on foreign ores entering this country and 6 cents a pound on bar, pig, and metallic tin, when domestic production exceeded 1,500 tons per year. It is a coincidence that this tariff law was enacted at the same time domestic smelting of foreign ores was started. Of course, this duty was never levied, as domestic tin production has never attained the level stipulated in the enactment described.

The tin-plate industry in the United States owes its growth in world superiority to the McKinley Tariff. Enacted in 1890, this bill placed a protective tariff of 2.2 cents per pound on tin plate.

FUTURE OF TIN MINING IN CALIFORNIA

The future of tin mining in California, unfortunately, does not look encouraging. Repeated failures in operations that have been attempted, lack of orebodies of suitable size and value, lack of reports of new and substantiated occurrences, all add up to a general dismissal of possible future operations in this State. Of course, if we must have tin at any cost, it might be possible to provide a few thousand tons from the known deposits in this State, but no future situation which requires measures as drastic as that is likely. There is only one hope. Tin is not easily recognized when finely disseminated and perhaps with the pressure of the times, prospectors will take notice of any signs of tin ore and have appropriate tests made.

MINERALOGY OF TIN

TIN MINERALS

TABLE IV

BEST-KNOWN TIN MINERALS

Mineral	Chemical Composition	Significant Facts
Cassiterite	SnO_2	Principal tin mineral; only one reported in California
Stannite	Cu_2FeSnS_4	Second in importance to cassiterite
Franckeite	$3\ PbSnS_2\text{-}Pb_2FeSb_2S_8$	Very rare; collector's item
Cylindrite	$3\ PbSnS_2\text{-}SnFeSb_2S_8$	Very rare

Since the last three minerals in Table IV are unknown in California, and since stannite, the only important mineral in that group, generally occurs at depth, this discussion of the mineralogy of tin will be confined to cassiterite, the principal mineral.

Cassiterite, or tin oxide, is found in crystals, crystalline and colloform masses, pebbles, and grains. The crystals are tetragonal and usually prismatic or pyramidal in habit. The hardness of cassiterite is 6½ on the Moh scale (can not be scratched by knife blade) and its specific gravity is 7, rather high. It ranges in color from yellow or colorless to brown or black, and a freshly broken face gives an adamantine luster. The principal qualities for identification of this mineral on sight are its high specific gravity and its brilliant luster.

Tin oxide is insoluble in acids but when heated with a blowpipe on a charcoal block may be reduced to the metal. To do this, the mineral is first powdered and then fused with sodium carbonate, sulfur, and a little powdered charcoal. This will produce a metallic button and a straw-colored coating near the fusion. When the coating is heated with a small amount of cobalt nitrate solution, it assumes a bluish-green color.

FIELD DETERMINATION OF TIN

It is often difficult for persons in the field to determine if rocks, likely to carry tin, are actually tin-bearing. The added expense of handling and assay discourages further determinations, and it is quite possible that many tin deposits have been overlooked in this way.

The rock suspected of carrying tin should be crushed with a hammer to 30 or 40 mesh (depending on the size of the mineral grains) in an iron mortar or on an iron block. It should next be panned to obtain a rough concentrate, and then should be cleaned on a vanning plaque. A few grams of the concentrate should then be placed in a test tube with dilute hydrochloric acid, and about one gram of zinc shavings should be added. After contact for a few minutes, the mineral should be washed on the vanning plaque and dried in a piece of soft cloth. The mineral grains should then be polished by being rubbed thoroughly in the cloth. If the mineral is cassiterite, the grains will be seen under a magnifier to be coated with metal of a white color. The zinc metal reacts with the acid to liberate hydrogen which reduces the cassiterite to tin metal according to the following chemical equations:

$$Zn + 2\,HCl \longrightarrow H_2 + ZnCl_2$$
$$SnO_2 + 2H_2 \longrightarrow Sn + 2H_2O$$

This test is conclusive evidence of the presence of tin, and is accurate as well as simple.

GEOLOGY OF TIN

OCCURRENCE OF TIN

The major part of the world's tin production is from eluvial (residual) or alluvial deposits. In California, however, very little tin has been found in placer deposits, for the gravels were worked primarily for gold, and cassiterite, if present, was not easily recognized by the ordinary miner. Also, rocks in the regions worked for gold are not, in general, particularly favorable sources for tin.

It can be said conclusively that all tin occurs in or near acid igneous rocks. These rocks may be granite, syenite, granite porphyry, quartz porphyry, pegmatite or quartz. The pegmatite and quartz generally occur as veins traversing granite and metamorphosed sedimentary rocks such as schists, phyllites, slates and quartzites or metamorphosed limestone. Jones (25, p. 54) shows how the composition of the granite instrusion affects the presence of tin:

> "The Benom Range in Pahong, Federated Malay States, runs approximately parallel to the Main Range of the Peninsula, the foot of one range being only about 12 miles from that of the other. Practically no tin deposits have ever been found in the Benom Range, whereas tin deposits are worked extensively in innumerable parts of the Main Range, and within 13 miles of the foot of the Benom Range. Colorless and pale colored mica, muscovite, and lepidolite are rare or absent in the granite of the Benom Range and are very abundant in that of the Main Range; and hornblende is a common constituent over large areas of the Benom granite and is rare or absent in that of the Main Range. Without going into further details we can state that the granite of the latter range is of more acid type than that of the

> Benom Range; and a study of the world's stanniferous granites shows that they are special types of granites, limited in their occurrence to special parts of the earth's crust . . ."

From this it can be inferred that the granodiorites, which predominate in the Sierra Nevada, being more basic than true granites, are not so likely to carry tin as more acid granites and pegmatites.

ORIGIN OF TIN ORE

Primary tin deposits result from in-filling of fissures by the more acid products of magma in its later stages of consolidation. The gases included in the magma escaped, filling the fissures, and permeated the fissure walls for some distance. These gases include borates, fluorides, sulphides, and arsenides—all acid constituents. Tin is probably carried with fluorine or boron into the fissures. Jones (25, p. 56) makes the following statement:

> "The fissuring in the granite is most pronounced near its periphery, so that stanniferous veins are generally much more common on the margins of granite masses than towards their center; and by far the greatest bulk of the world's supply of tin minerals is obtained from lodes near the granite contact, where they traverse the granite or the adjacent metamorphosed rocks."

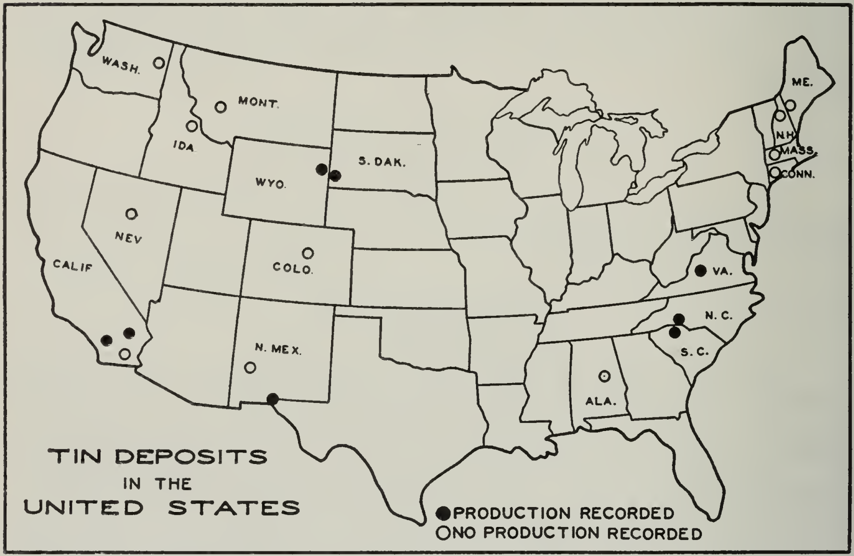


FIG. 3. Map showing the principal deposits of tin in the United States.

ORE-FINDING GEOLOGY

The logical place to look for tin is near pegmatite intrusions in highly acid granite of an early age. Minerals often associated with tin include tungsten, quartz, tourmaline, mica, topaz, fluorite, beryl, apatite, molybdenum, arsenopyrite, bismuth and bismuthinite, and very small amounts of pyrite, pyrrhotite, chalcopyrite, galena and sphalerite. Absence of pyroxenes, amphiboles, magnesium micas, and garnet should be encouraging.

The tin occurs in greisen or areas adjacent to pegmatite intrusions rather than in the pegmatite itself. All tin deposits seem to be associated with Jurassic or pre-Jurassic intrusions.

TIN ORE DRESSING

The beneficiation of tin ores as practiced in this country has never been highly successful. Perhaps some of the major reasons are not only the complexity of the ore but the attempts to use methods developed in other countries under vastly different conditions, particularly as regards the cost of labor.

Since no workable amount of alluvial tin is known in California, the practice of dredging and gravel pumping used on gravel deposits in Malaya will not be dealt with here. As a matter of record, it might be stated that there is very little difference in dredging procedure in the gold and tin fields.

Since lode, rather than placer tin is most likely to be found in this country, a knowledge of the procedure for concentrating tin ores would be of value to anyone contemplating operations in the industry.

The Anchor mine in Tasmania treats finely disseminated cassiterite in granite, which is quite similar to California ore. The ore runs from 0.10 to 0.16 per cent, the tailings 0.03 per cent, and the concentrates about 68 to 73 per cent tin. Overall recovery is from 70 to 75 per cent. Although this treatment plant is more or less obsolete with its use of buddles and kieves, it shows that repeated cleaning without regrinding can produce a good concentrate. The design of this plant could be altered to bring about much better recovery, although it is a matter of conjecture whether ores as low as 0.1 per cent ($1.00 per ton) could be profitably worked in this country.

CONCENTRATION OF TIN ORES

The specific gravity of cassiterite makes the separation of common gangue minerals, particularly in placer deposits, a fairly simple mechanical process.

In placer deposits the concentration of tin ores is accomplished with concentrating machinery like that used to recover gold. Panning and sluicing are common in the far eastern gravel deposits. On dredges, tabling and jigging are common. Ore from some placer deposits must be crushed in order to completely free the cassiterite from the gangue, which is usually silicious.

The ore from lode deposits rarely receives such a simple treatment because of the presence of metal sulfides which approach or equal the specific gravity of cassiterite.

COMMON TREATMENTS OF COMPLEX ORES

There are many complex ore treatments in the tin industry, but most of them are only suited to a particular deposit and its peculiarities. An outline of processes most common in complex ore treatment is given below.

Calcining Roast Plus Mechanical Separation

Heated in any type of atmosphere at red heat, cassiterite fails to be changed, but the composition of many gangue minerals is so altered that subsequent mechanical separation is entirely successful. Volatilization of sulphur, arsenic, and antimony, if present, results. Original metallic constituents, such as iron, zinc, bismuth, and copper, remain primarily as oxides. Lead sulphate, iron arsenate, some unaltered sulphides, and tungsten compounds also remain. Calcination is usually carried out in rotary kilns at a temperature of approximately 600°C.

Tabling, magnetic separation, jigging, and flotation, are the treatments that follow calcination. The application of one or all of these, of course, depends on the original composition of the ore or concentrates.

A process such as is outlined above is appropriate only for high-grade ores or concentrates. The cost of calcining low-grade materials would be prohibitive.

Leaching

Some compounds, normally insoluble, are rendered soluble through calcining. It is necessary that an acid solution be employed when any leaching following a roast is used, since very few of the resulting compounds are at all soluble in water. Here again is a process which is only applicable to concentrates, because of its high cost. The conditions under which such a process is carried out must be determined experimentally for each individual case.

Sintering

To remove tungsten from tin concentrates as a soluble tungstate is desirable because of the comparatively high value of tungsten. A partial fusion of tin concentrates containing tungsten, with sodium carbonate or sodium sulphate, has been used with fair success. Careful control is necessary in a process of this nature since loss of tin can result through the use of excess sodium salts.

Sintering with sodium chloride in an oxidizing atmosphere, although never actually tried on tin concentrates, has been used to remove similar gangue from other valuable minerals. The process produces soluble sodium sulphate from the sulphur and forms soluble chlorides of the gangue metals, which are removed by leaching.

Flotation

Flotation seems the logical solution to problems involving high-sulphide-content ores because of its cheapness and high tonnage capacity.

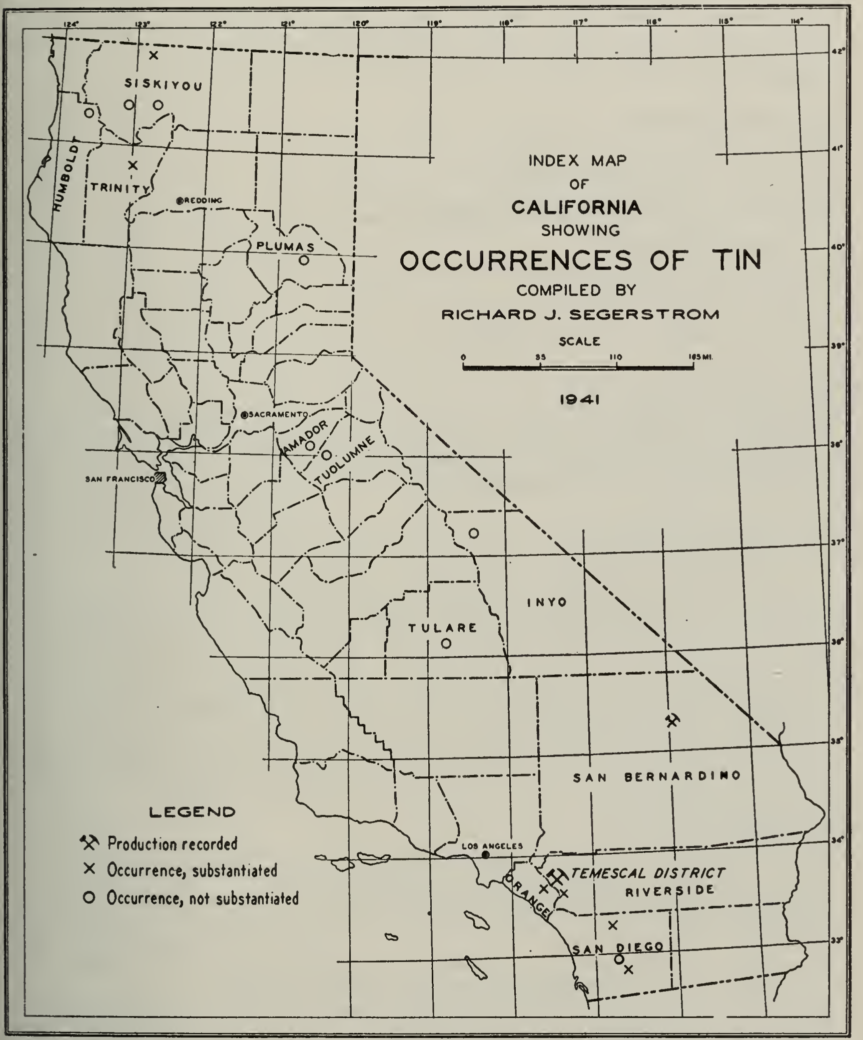
The concentration of tin ores is accomplished in two ways: (1) by flotation and removal of the sulphide gangue; and (2) by flotation of the cassiterite. The most common use of flotation is probably to float the sulphide constituents from the already mechanically concentrated tin ore, leaving the cassiterite as a tailing product. This type of concentration would be of no use if the tin occurred as a sulphide, as in some Bolivian ores.

A patented process (Gaudin 39) for the flotation of cassiterite through the use of copper sulphate gives over 95 percent recovery, although it is an uncommon procedure.

TYPICAL GRAVITY CONCENTRATION OF TIN ORE

Gaudin (38) gives a flow sheet of a typical gravity concentration plant used in Bolivia:

> "The ore is reduced to $1\frac{1}{2}$ in. by a jaw crusher; then to 20 mesh by a ball mill, a grizzly screen and rake classifier being used to facilitate the task of the crusher and control the operation of the mill, respectively. The minus 20-mesh ore is classified into several grades by a hydraulic classifier, each grade being concentrated on a shaking table. The tables each make a concentrate, a middling and a tailing. The middlings are retreated to yield additional concentrate and a product requiring further treatment. That product is crushed to 200 mesh in a regrind mill controlled by a bowl classifier which also received an overflow from the hydraulic classifier. Slime concentration is a two-stage vanner treatment."


124°
123°
122°
121°
120°
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118°
117°
116°
115°
114°
42°
41°
40°
39°
38°
37°
36°
35°
34°
33°
INDEX MAP
OF
CALIFORNIA
SHOWING
OCCURRENCES OF TIN
COMPILED BY
RICHARD J. SEGERSTROM
SCALE
0
55
110
165 MI.
1941
SISKIYOU
HUMBOLDT
TRINITY
REDDING
PLUMAS
SACRAMENTO
AMADOR
TUOLUMNE
SAN FRANCISCO
INYO
TULARE
SAN BERNARDINO
LOS ANGELES
ORANGE
TEMESCAL DISTRICT
RIVERSIDE
SAN DIEGO
LEGEND
⚒ Production recorded
× Occurrence, substantiated
○ Occurrence, not substantiated

FIG. 4. Index map of California showing recorded occurrences of the tin mineral cassiterite.

SUMMARY OF RECORDED TIN OCCURRENCES IN CALIFORNIA

In order to avoid possibility of not reporting a tin occurrence of merit, all known claims of tin occurrences are included in this summary, even though many claims that are reported are held in doubt. The difficult nature of a field test for tin, particularly when in quantities below 1 percent, accounts for many misunderstandings in reports.

An attempt has been made to differentiate, on the accompanying index map, between (1) those deposits from which some production has been recorded, (2) those deposits which are merely occurrences of the mineral cassiterite, and (3) occurrences ''not substantiated'', or those deposits of which the record may not be correct.

Citations given under the heading ''references'' refer to the bibliography which appears at the end of this report.

AMADOR COUNTY

Location: Near Mokelumne River

Description: 5-foot vein (reported)

Reference: Hess and Graton 05, page 165

HUMBOLDT COUNTY

Location: Near Orleans

Description: Bits of tin were observed in gold sluices in this region

Reference: Eakle, A. S. 23, page 22

INYO COUNTY

Location: On Bishop Creek

Description: Cassiterite nuggets are reported to have been found here, but the author could not verify the statement by inquiry (1941)

Reference: Mining and Scientific Press 01

ORANGE COUNTY

Name: Trabuco Tin Mine

Location: Trabuco Canyon; reached by poor road

Description: About 400 feet of workings; mill buildings empty; no activity

Reference: Verified by author

PLUMAS COUNTY

Location: 3 miles above Big Bar on Middle Fork of Feather River

Description: Placer nuggets

References: Blake, W. P. 82; Hanks, H. G. 84, page 120; 86, page 98; Rolker, C. M. 95, page 535

RIVERSIDE COUNTY

Name: Temescal Tin Deposit (Cajalco Mine)

Owner or Locator: American Tin Corporation (1929)

Location: Near Corona, 5 miles south of Arlington, in Secs. 2, 3, 10, 11, T. 4 S., R. 6 W., S.B.

Description: An immense vein system about 2 miles in diameter; country rock is granite, and the tin is found associated with tourmaline

References: Fairbanks, H. W. 93; Goodyear, W. A. 88, page 506; Hanks, H. G. 84, pages 120-122; 85, page 106; 86, page 98; Hess and Graton 05, page 165; Merrill, F. J. H. 19, pages 547-550; Rolker, C. M. 95, pages 536-538; Sampson, R. J. 35, pages 515-518; Storms, W. H. 93, page 382; Symons, H. H. 29; 30; Tucker, W. B. 21, page 332; 24; Tucker and Sampson 29, pages 495-499; U. S. Geological Survey, Elsinore quadrangle; see bibliography for other citations

Name: Temescal Placer Mine

Owner or Locator: American Tin Corporation (1900)

Location: 129.67 acres, lots 85-86, T. 4 S., R. 7 W., S.B.

Description: Placer claim; extensive work done

Reference: Patent Volume 331, pages 43-45 (1900)

Name: Chief of the Hills group

Owner or Locator: J. M. Mack and C. L. Berry of Elsinore, California

Location: About 2 miles northeast of Elsinore, in Sec. 4, T. 6 S., R. 4 W., S.B.

Description: Tin occurs associated with tourmaline in dikes which traverse a lens of metamorphics in the granite country rock. In a personal interview, Mr. Mack stated to the author that he had received assays of 7 percent tin from samples taken on this claim

References: Sampson, R. J. 35, page 516; Tucker and Sampson 29, page 496

Name: Moore Tin Deposit

Owner or Locator: Robert L. Moon Estate, Riverside, California (1935)

Location: 600 acres in Secs. 13, 14, 23, and 24, T. 4 S., R. 6 W., S.B., about 2 miles southeast of Cajalco Hill and 7 miles south of Arlington

Description: Parallel veins in which tin is associated with tourmaline are common in this district; small amounts of work have been done, but little ore has been uncovered; property idle

References: Sampson, R. J. 35, pages 516-517; Tucker and Sampson 29, page 496; verified by author

Name: Black Rock Tin Deposit

Owner or Locator: Black Rock Tin Syndicate

Location: 400 acres, located in Secs. 18 and 19, T. 4 S., R. 5 W., S.B., 2 miles southeast of Cajalco Hill on the Rancho el Sobrante de San Jacinto, 7 miles south of Arlington

Description: Traces of tin have been found with tourmaline in the many dikes which traverse the granite at this locality; copper is also found in small quantities in the region.

References: Sampson, R. J. 35, page 516; Tucker and Sampson 29, page 496

Name: Holmes Ranch Deposit

Owner or Locator: Lawrence Holmes, Arlington, California

Location: 560 acres in Sec. 12, T. 4 S., R. 6 W., S.B., 1½ miles southeast of Cajalco Hill and 5 miles south of Arlington

Description: In a tourmaline vein cutting granite, traces of tin (less than 0.5 per cent) have been found; no work of any consequence has been done.

References: Sampson, R. J. 35, page 516; Tucker and Sampson 29, page 496

Name: South Block Tin Group

Location: 80 acres in Sec. 19, T. 4 S., R. 5 W., S.B., 3 miles southeast of Cajalco Hill

Description: Tourmaline veins in granite, 6 to 10 feet in width; samples show the outcrops to be of very low grade

References: Sampson, R. J. 35, page 517; Tucker and Sampson 29, page 497

SAN BERNARDINO COUNTY

Name: Apex Mine (two claims)

Owner or Locator: Dutton and Hammond, of Cima, California

Location: Sec. 25, T. 15 N., R. 13 E., S.B.

Description: Tin ore occurs in small kidneys along talcose slip in dolomitic limestone; 20 pounds of ore extracted carried 5 per cent tin; developed by a shaft 65 feet deep; small production

Reference: Personal communication from W. B. Tucker, District Mining Engineer, State Division of Mines, July 10, 1941

SAN DIEGO COUNTY

Name: Cassiterite Placer Claim

Owner or Locator: Guy Hogan, Pine Valley, California

Location: Sec. 19, T. 16 S., R. 5 E., S.B.

Description: Claim is for gold and silver; owner states that he claims that tin should be found in this locality; spectrographic test of samples submitted by the owner to the author of this paper indicates that tin is present to the extent of 0.01 per cent.

References: Merrill, F. J. H. 16, page 669; verified by the author

Name: San Diego, Panama, Exposition

Owner or Locator: Carson, Haney, and Fiske, of Pasadena, California

Location: Sec. 12, T. 9 S., R. 3 E., S.B.

Description: Small amounts of tin occur in pegmatite dikes that cut well-faulted granodiorite

Reference: Schaller, W. T. 16

Location: East slope of Laguna Mountains

Description: Cassiterite nuggets found by placer miners

References: Merrill, F. J. H. 16, page 669

SISKIYOU COUNTY

Name: Hungary Creek Deposit

Location: Near Zuleka

Description: The presence of tin in this county is thoroughly substantiated, though no large occurrences have been found

References: Eakle, A. S. 23; Hess and Graton 05, page 165; Irelan, W. 88, page 591; Pabst, A. 38; Rolker, C. M. 95, page 535

Location: Near Kangaroo Lake about 16½ miles east of Callahan

Description: Investigations have failed to substantiate the presence of tin in this region

Reference: Logan, C. A. 24

Location: Sawyers Bar

Description: Placer tin taken from gravels

References: Eakle, A. S. 23; Pabst, A. 38

TRINITY COUNTY

Location: Near Weaverville

Description: A few nuggets of cassiterite (not in place) have been found at this locality; the author found that these nuggets, though small, were pure cassiterite

References: Hanks, H. G. 84, page 120; 86, page 98; Hess and Graton 05, page 165; Rolker, C. M. 95, page 535; Whitney, J. D. 65, page 181; verified by author

TULARE COUNTY

Location: F. B. Bailey ranch above Springville

Description: Merely a reported occurrence; nothing was found to substantiate the presence of tin

Reference: Laizure, C. McK. 23

TUOLUMNE COUNTY

Name: White Lead Gravel Claim

Location: On Stanislaus River 4 miles north of Columbia

Description: Tin was reported to have been found in the gold sluice on this claim, but none has since been found in the region

References: Eakle, A. S. 23, page 22; Hess and Graton 05, page 165; Preston, E. B. 93, page 507; Rolker, C. M. 95, page 535

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CALIFORNIA QUICKSILVER PROGRAM OF THE FEDERAL GEOLOGICAL SURVEY *

By Edwin B. Eckel **

INTRODUCTION

Most readers of this Journal are aware that the Federal Geological Survey and the Bureau of Mines are now engaged in a far-reaching study of the deposits and reserves of strategic and critical minerals in this country and in Latin America. Only the Geological Survey's investigation of California quicksilver deposits is discussed here, but it should be realized that this program differs only in detail from those for other metals and for other areas.

Strategic minerals may be briefly defined as those essential to National defense in which this country is deficient in time of war, either because it actually lacks sufficient supplies or because it ordinarily depends on foreign sources because of price or other considerations. The principal objective of the present program, then, is to make an inventory of this Nation's supplies of those minerals that are essential to defense or security. In addition to quicksilver, these minerals classified as strategic include antimony, tungsten, manganese, chromium, tin, nickel, mica and optical quartz.

First steps in the present program, using funds allocated by the Public Works Administration, were taken in 1938, some months before the outbreak of hostilities abroad. Since that time the program has expanded in size and scope until now it absorbs the energies of a greatly increased proportion of the enlarged scientific and technical personnel of the Geological Survey.

ACKNOWLEDGMENTS

Throughout our work to date we have met with cordial cooperation and assistance from everyone concerned. Geologists at the universities have been very helpful and have given freely of their time and knowledge both in field and office. In addition to providing us with a background of knowledge of California geology based on their personal experience, several of them have furnished us with unpublished maps and other data that were of utmost value in our work. In some cases, at least, this generosity has resulted in personal or professional sacrifice on the part of contributors, for we have perforce anticipated them on publication of maps and descriptions of certain areas, although we have gratefully acknowledged their help and advice. In addition to our appreciation expressed here, we can only add our hope that before the program is completed we shall be able to add enough to the basic knowledge of California geology to justify their patriotic generosity.

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** Geologist, U. S. Geological Survey.

To mention the operators who have assisted us in various ways would be to list the quicksilver mine owners, operators, engineers, and miners of the State. As with the geologists, it is our earnest hope that we can contribute enough specific, applicable, information on the geology and distribution of quicksilver deposits to repay the operators in part for their cooperation. Many operators have given freely of their time and knowledge and many too have furnished us with maps or other information, some of it of a highly confidential nature. With respect to confidential information, it is perhaps advisable, though we hope unnecessary, to reaffirm a long-standing principle of the Geological Survey—that confidential information on private properties is never made public without express permission of the owners.

We have come to rely on the California Division of Mines as one of our chief sources of information. Constant use is made of its published maps, reports, and statistics, not only in formulating plans but in preparing our own reports. Its officials, especially Walter W. Bradley, State Mineralogist, and Olaf P. Jenkins, Chief Geologist, are ever ready to supply us with needed data and advice.

In these acknowledgments the use of plural personal pronouns does not reflect editorial usage but instead is meant to express the feelings of the entire geologic staff of the Geological Survey, from the director to the newest recorder. The writer, however, would here step aside from this all-inclusive group long enough to express personally his deep appreciation to all his colleagues who have had any part in the California quicksilver program, particularly to those who are so ably and enthusiastically carrying the principal burdens of the field work.

OBJECTIVES AND METHOD OF ATTACK

The principal objective of the California quicksilver program is like that of the strategic minerals program as a whole—to make an inventory of California's supplies of quicksilver. We want to know the reserves of ore, both probable and possible. We must also know the rate of production that can be maintained at given prices. As present world conditions are likely to continue for some time, we also want to know where search for new ore will be justified.

Attainment of these objectives involves geologic mapping and intensive study of every quicksilver mine and district in the State. It was apparent from the start that studies of individual mines, no matter how thorough, are not enough. All the deposits in a given district must be examined in the light of the geologic framework of that district. This requirement calls for areal geologic mapping in as great detail as time, available base maps, and other circumstances allow. As with individual mines and districts, so too with the deposits of the State as a whole; differences between deposits and districts exist, to be sure, but they are all placed on a regional geologic framework and the same pattern runs through them all. The pattern is dim and obscure in many places, but once recognized it can be traced almost everywhere, permitting valid and useful generalizations, both geologic and economic. The geology of California and particularly of the Coast Ranges, where most of the quicksilver is concentrated, has been studied intensively by many very able workers for many years, though, as everywhere else, many problems are still unsolved. Quicksilver deposits, too, have been studied for many years by State, Federal, university, and private geologists and engineers. These vast stores of accumulated knowledge are the foundations on which the Survey's present studies are being built.

There are no delusions that reserves of quicksilver ore can be estimated accurately, for quicksilver deposits are not generally amenable to exact measurement. Every district, mine, and prospect, however, will have been seen in the course of this program, and the geologic setting of each will be be known. We therefore expect to have reasonably good ideas as to the reserves, the rate of production that can be maintained, and the most favorable prospecting ground. We know that if sufficiently detailed geologic studies are made it will be possible in most places to determine the structural control of known ore deposits. This information is of great value in computing the size and shape, and hence the reserves, of unworked or partly worked deposits, and also in guiding the search for new ore.

Concurrently with the geologic investigations, studies are being made of the economics of quicksilver, particularly as to the relationship between costs, prices, and rate of production. It is obvious that only under unthinkably adverse world conditions will our quicksilver needs be supplied without some profit to the owners and operators. It thus becomes part of the problem to know what deposits can be worked profitably for quicksilver under varying economic conditions.

Geologic investigations alone, no matter how detailed, can never give the complete story. Actual physical exploration is therefore needed in many places. This work is in the province of the Bureau of Mines, which is engaged in a program of exploration involving drilling, trenching, sampling, and other forms of physical measurement. The Bureau's projects are of course chosen by its own engineers, but it is part of the Survey's duty to recommend projects for consideration where study of the local geology has indicated that they have promise. Several California quicksilver deposits have been or are being explored by the Bureau of Mines on the recommendation of Survey geologists, and others will be prospected in the future. In addition to recommending likely projects, it is the Survey's practice to assign a geologist to the exploration party, both to help interpret the results of the exploration in the light of the regional or local geology and to obtain first-hand knowledge of additional geologic facts that are brought to light.

PRESENT STATUS AND FUTURE PLANS

The accompanying table shows the present status of the Survey's program and of the work accomplished so far. All the principal productive areas in the State will have been covered by the Summer of 1942. Study of the remaining districts should be completed by the end of 1942. It is hoped that reports on all of them will have been prepared by the following Spring.

It should also be noted that the information being gathered is made available to defense agencies in Washington and to the public at large as soon as possible after the field work is completed. This procedure calls for hurried preparation of preliminary reports by the field geologists, often far from established offices and without library or laboratory facilities. Some errors, omissions, and discrepancies will doubtless crop up from time to time, but since ''time is of the essence'' in an emergency, the reports will be more useful if made available for use promptly than they would be if they were delayed for finishing touches of form and content. These preliminary reports may be followed by more comprehensive reports whenever it seems advisable.

The geologic examination of all districts will not complete the program by any means, and it is expected that Survey geologists will continue their studies at least until the end of the present war. It will be necessary to keep our knowledge of active mines up to date, to examine immediately all new discoveries, to assist the Bureau of Mines in its explorations, and in short to keep in close touch with all factors that have a bearing on production or reserves of quicksilver.

QUICKSILVER DEPOSITS

PROJECTS COMPLETED AND

No.	District	County	Approximate area mapped (square miles)	Geologist in charge
1	Mount Diablo	Contra Costa	2	C. P. Ross
2	Mayacmas and Sulphur Bank	Napa, Lake, Sonoma	25	C. P. Ross
3	San Simeon, Adelaida, and Rinconada	San Luis Obispo	200	E. B. Eckel
4	Willow Ranch, etc.	Modoc	10	C. P. Ross
5	Coso	Inyo	300	C. P. Ross
6	New Idria	San Benito, Fresno	135	E. B. Eckel
7	Stayton	San Benito, Merced	25	E. H. Bailey
8	Panoche	San Benito	100	R. G. Yates
9	Parkfield	Monterey, Kings	20	E. H. Bailey
10	New Almaden	Santa Clara	80	E. B. Eckel
11	Mayacmas (southeastern part)	Lake, Napa	100	R. G. Yates
12	Mayacmas (northwestern part)	Sonoma	60	E. H. Bailey
13	Wilbur Springs (Sulphur Creek)	Colusa, Lake	45	W. B. Myers
14	Knoxville	Lake, Napa, Yolo	50	Paul Averitt
15	Phoenix, Orestimba (Del Puerto)	Stanislaus	75	H. E. Hawkes and F. G. Wells
16	Patricks Creek	Del Norte	10	F. G. Wells

OF CALIFORNIA
UNDER WAY IN 1941

Associates and Assistants	Dates of field work	Status
	August, 1939	Published: U.S.G.S. Bull. 922-B (1940)
J. R. Bovyer, G. H. Crowl, J. W. Harding, Jr.	July-Sept., 1938	Published (prelim.) U.S.G.S. Bull. 922-L (1940)
R. G. Yates and A. E. Granger	Oct. '39-May '40	Published: U.S.G.S. Bull. 922-R (1941)
		Published: U.S.G.S. Bull. 931-B (1941)
R. G. Yates	June, 1940	Manuscript completed; publication delayed for completion of Bureau of Mines exploration
R. G. Yates, W. B. Myers, R. A. Brown, A. E. Bradbury	Sept. 1940-May 1941	Report in process of publication
W. B. Myers	Mar.-May '41	Report in process of publication
L. S. Hilpert	May-July '41	Report to be prepared during winter of 1941-42
W. B. Myers, F. B. Roberts	May-July '41	Report in process of publication
Paul Averitt and others	Begun July '41	Field work in progress intermittently. Completion expected by mid-1942
L. S. Hilpert	Begun July '41	Field work to be completed Dec. 1941; report to be prepared during spring of 1942
F. B. Roberts	Begun Aug. '41	In progress; field work to be completed early in 1942
F. R. Kelley	Begun Aug. '41	In progress; field work to be completed early in 1942
	July-Nov. '41	Report to be prepared during the winter of 1942
D. P. Wheeler	Jan.-June '41	Report on chromite and quicksilver deposits in process of publication
J. Livermore, P. Richards, D. Phoenix	Begun Oct. '41	In progress; field work to be completed early in 1942

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Division, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of new laws and official regulations and notices affecting the mineral industry.

RECENT DEVELOPMENTS IN THE TUNGSTEN RESOURCES OF CALIFORNIA[a]

By W. B. Tucker and R. J. Sampson, Mining Engineers[1]

Since the publication of our April, 1941, issue of the California Journal of Mines and Geology on the Tungsten Resources of California, there has been considerable development and some discoveries of additional deposits. It is the purpose of this paper to describe these new developments and discoveries.

The most notable of these developments has occurred in the Darwin area. It was here that C. W. ("Curley") Fletcher, with the aid of an ultra-violet ray light, found that scheelite in commercial quantities existed in the dumps of some of the old lead-silver properties east and southeast of Darwin. After making shipments of assorted ore from these dumps which, reputedly, carried 5% WO_3, he consolidated several groups of these claims and turned them over to the Pacific Tungsten Co., which company is now treating some 135 tons of ore per day in its mill at Keeler.

Following this development, investigation of the ores of the mines of the Imperial Metals Co. divulged the fact that scheelite in appreciable quantities occurs in these ores and this company is now erecting a 250-ton mill for the concentration and separation of the tungsten and lead minerals. Also, of great importance to the industry is the fact that the United States Vanadium Corp. has completed and put into operation its 1400-ton concentrator on Pine Creek, some 18 miles west of Bishop.

Description of these various enterprises will be found in the body of this report.

ALPINE COUNTY

Wolframite Mine, F. Will Küechler of Minden, Nevada, and 1121 W. Walnut Street, Stockton, California, reports high-grade veins of scheelite three miles north of Red Lake on the Carson Pass road. It is on agricultural patented land and he has a lease from the owner.

Zaca Mine, (silver). Hübnerite occurs associated in the ore of the Zaca Mine near Markleeville.[2]

FRESNO COUNTY

Baziuk Mine is in Sec. 22, T. 12 S., R. 27 E., M. D. M., adjoining the Garnet Dike Mine. Owner is B. Baziuk, Fresno, Calif.

The deposit occurs at or near the contact of granodiorite and crystalline limestone. Gangue is largely garnet and epidote. It is developed by open-cuts.

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[a] March, 1942.

[1] Data relative to Fresno, Madera and Tulare counties were gathered by H. G. Hubbard, Junior Mining Engineer, San Francisco office; and on Shasta County by J. C. O'Brien, District Mining Engineer, Redding.

[2] Gianella, Vincent, Epithermal hübnerite in the Zaca Mine, Alpine County, California: Econ. Geol. Vol. 33, No. 3, May, 1938.

The ore is delivered to mill by a 500-ft. aerial tram. The mill consists of jaw crusher, screen, ball mill and table; capacity 30 tons per day. Idle.

Garnet Dike Mine, comprising 2 claims, is on the north side of the Kings River, in Sec. 22, T. 12 S., R. 27 E., M. D. M., about 13 miles by road and trail from the Kings River State Fish Hatchery; elevation 2800 ft. Owners are Sheridan Bros., c/o Kings River Fish Hatchery, Fresno, Calif.

The deposit is of the contact-metamorphic type, occurring at or near the contact of granodiorite and crystalline limestone. The gangue is largely garnet and epidote, with some quartz and calcite and varying amounts of pyrite. The ore as sorted and sent to the mill, is said to carry 1% WO_3.

Development consists of 4 open cuts and a tunnel 75 ft. in length.

A 700-ft. aerial tram delivers ore from the mine to the mill which consists of 6-in. by 12-in. jaw-crusher, 16-mesh trommel to 25-ton Wheeler ball mill to Overstrom table; capacity 25 tons per day. Power is supplied by gas engines.

Houghton Bros. Mine, comprising 12 claims, is on Dinkey Creek in Sec. 3 and 4, T. 12 S., R. 26 E., M. D. M., about two miles by road north of the Pacific Gas and Electric Company's Balch Camp; elevation, 1800 feet. Owners are Ernest F. Houghton and two brothers, Sanger, California.

The deposit is contact-metamorphic and occurs at or near the contact of granodiorite and crystalline limestone. Gangue is chiefly garnet, epidote and quartz. It is now being developed by many small and scattered open-cuts.

The ore is delivered to mill by a caterpillar-drawn sledge. The mill consists of jaw-crusher, screen, ball mill and table; capacity 20 tons per day.

Parlier Prospecting Association, comprising one claim is on a good road in Drum Valley 12 miles easterly of Rosa; elevation 1500 ft. Owners: C. A. Parlier (and four others), Parlier, California. In the early part of 1942 this deposit, developed by open-cuts, produced 600 tons of good ore, which was hauled to a custom mill.

It is reported to occur at or near a contact of granite and marble. The ore is largely garnet and quartz with scheelite in frequent high-grade masses.

Recently (March, 1942) leased to Bruce McDonell of Sacramento.

The following statement on the ''Tungsten occurrences in Fresno district was contributed March 4, 1942, by Edgar (''Red'') Wilkins of The Twining Laboratories, Fresno.

''The main occurrences of tungsten in the Fresno district to date seem to be falling into a rough pattern along a broad strip extending from the Kings River Fish Hatchery on the main Kings River, north and eastward, embracing the Spanish Mountain District, plunging beneath the San Joaquin to appear at numerous places on the north side thereof; it disappears again to reappear notably at Jackass Meadow District.

''This belt, but sketchily prospected as yet, supports two operating mines on its southern end, namely, The Garnet Dike Mine, Kings River

Fish Hatchery, and the nearby Baziuk property. On northward at Dinkey Creek, just below the public camp ground, a 75-ton mill has been installed by the Tungstor Mining Co. At Dinkey Creek, near Balch Camp, the Houghton Bros.' Mine is assembling a mill. Still farther north on the north side of the San Joaquin, notable occurrences appear at the Wisseman and Carruthers' properties at Fish Creek.

''Two small mills are in operation at both of these properties. Farther north and east at Jackass Meadow, L. C. Thornton is assembling a 50-ton mill for operation as soon as the snow melts.

''Numerous occurrences to the westward of this general strike occur both in the primary formation and even extend into the Sierra Nevada foothill complex. Criteria in this belt remain to be established. The notable strikes in this extented belt are the Al Feuerstein property in Burr Valley, the Rapp Bros.' property near Coarsegold, and several small showings on Fine Gold Creek near O'Neals.

''The tungsten mineral in all these deposits is scheelite, occurring in contact metamorphic deposits. The sedimentary rocks are limestones and dolomites, and the common associated minerals are garnet, quartz, epidote, pyroxenes, and the amphiboles.

''Chemical analyses of the concentrates produced from this district show low phosphorus, molybdenum, copper, and sulphur content, and points to the conclusion that we may have embraced in the above rough outline an important addition to our national supply of this presently strategic mineral.

''I am indebted to the owners of the properties mentioned herein, for willing assistance in compiling the foregoing data, and especially to Andrew Thickstun, Consulting Mining Engineer and Mineral Technologist.''

INYO COUNTY

Defiance, Independence and Thompson Mines, 2 miles north of Darwin, have been leased by the Wagner Assets Realization Corp. and American Metals, Inc., to the Imperial Metals, Inc., S. B. Mosher, president and owner, 811 West 7th St., Los Angeles. The property consists of 48 patented claims and 20 held by location; in Sec. 13, 23 and 25, T. 19 S., R. 40 E., M. D. M.; elevation 5,100 to 5,600 ft.

For description of these properties, occurrence of the lead-silver ores and history of their past operations, the reader is referred to the bibliography given below.

It has recently been discovered that scheelite occurs in appreciable quantities in all of the orebodies of these mines except the Defiance. The occurrence of stolzite (lead tungstate, $PbWO_4$) in the lead orebodies is an interesting fact. Bunches of crystals of this mineral have been found in the Thompson orebodies. The scheelite seems to occur in definite bands in the lead orebodies, probably along lines of fracture and the highest grade material is found at the intersections of north-south and northeast-southwest fractures. No scheelite has been found on the footwall side. It is estimated that ores from the Independence, Thompson and Lane workings will average about 0.35% WO_3.

After shipments of some 9,000 tons had been made to the lead smelter, the present operators decided to erect a mill for concentration of the lead-silver ore and separate recovery of the scheelite. Pending completion of this mill, under construction (Nov., 1941), underground operations have been confined to the driving of the Radiore crosscut which is now in 1,450 ft., final objective being 4,400 ft. from the portal which is situated just east of the mill, a few hundred feet south of their camp. This crosscut will be used as a haulage tunnel from all of the mines. It is at an elevation of approximately 5,000 ft. which is 75 ft. below the lower level of the Defiance. At 1,271 ft. from the portal, the Rip Van Winkle or Mickey Summers vein was encountered. Here it proved to be 16 ft. wide, carries 25 oz. silver and 0.31% WO_3.

After exhaustive tests the following flow sheet for the mill was adopted and the concrete foundations have been poured, although somewhat hampered by sub-freezing temperatures at night.

From 270-ton coarse-ore bin to 15-in. by 20-in. jaw-crusher, inclined belt conveyor to 2 bins to Symons cone crusher, conveyor to 30-in. by 15-in. rolls, inclined conveyor to 300-ton conical steel bin; belt feeder to Esperanza drag classifier; sands to Bendelari jig; jig tails to waste; concentrates to Denver cleaner jig, concentrates to Dorr dewatering drag to 30-ft. drying tube; bucket elevator to steel cooling bin; to magnetic separator, where garnet is removed; to elevator to bin to 3-ft. by 3-ft. ball mill in closed circuit with Dorr classifier to conditioners to 6 Denver Sub A flotation cells to 3-cleaner cells and filter. Tails from rougher cells are the scheelite concentrates which go to filter. Tails from cleaner cells returned to roughers; middlings from Denver jig returned to Bendelari jig; middlings from Bendelari jig to 50-ton bin to 4½-ft. by 4½-ft. ball mill in closed circuit with Dorr classifier; overflow from Denver jig and Esperanza classifier to this Dorr classifier; overflow from classifier to 50-ton Dorr thickener; thickened pulp to conditioner to 4 Denver Sub A cells; tails to conditioner to 4 Sub A cells; tails to conditioner to 4 Sub A cells; concentrates from all these flotation cells to 6 Sub A cells to thickener to 3-leaf, 48-in. American filter to drying tube; tails from flotation circuits to thickening cone to 2 Wilfley tables; concentrates to thickener mentioned above; tails to waste. Capacity is 250 tons per day.

Thirty-two men are employed.

Bibl.: State Mineralogist's Reports VIII, p. 226; X, p. 211; XV, p. 98; XVII, pp. 287-288; XXII, p. 483, 486, 487; XXXIV, pp. 436-437 and 557-560; Reports of Director of the Mint, Precious Metals in U. S., 1883, p. 164; 1884, p. 103; U. S. G. S. Bull. 580, pp. 14-15.

Division Creek Tungsten Mine. It comprises 6 claims, situated on the east slope of the Sierra Nevada, in Sec. 5, T. 12 S., R. 34 E., M. D. M., 5 miles west of Division Creek power plant and 8 miles southwest of Aberdeen, a station on the Southern Pacific Railroad; elevation 7500 ft. Owners are J. L. McCullough, Independence, Calif., L. L. McAfee, T. W. Key, of Bishop, Calif., and H. N. Shepard, Los Angeles.

The discovery of scheelite was made in November, 1939, by L. L. McAfee and he and his associates located 6 claims. Due to high-grade float found, the Cardinal Gold Mining Co., of Bishop, took an option on the property in July, 1939, and started developing the property, exposing some very high-grade ore, some selected ore, carrying from 2% to 5% WO_3. The deposit is a product of contact metamorphism. It occurs on the contact of dolomite and granite. The strike is N. 30°

E., dip 45° to 60° E.; width varies 15 ft. to 25 ft. The length of the surface exposure of dolomite is about 75 ft. The mineralization consists of scheelite in a garnetiferous gangue.

Development consists of shallow open cuts and a tunnel driven N. 20° E., a distance of 25 ft. Fifteen tons of ore mined from this tunnel were shipped to the El Diablo Mining Company's mill near Bishop, with a reported recovery of 1.75% WO_3. A road is now being built from Scotty's Spring, on Division Creek, to the workings, a distance of 2 miles. Idle.

Imperial Metals, Inc. (see Defiance, Independence and Thompson Mines).

Jumbo Mine (gold) comprises 6 claims located southwest of Black Eagle Mine, on west flank of the Inyo Mountains, in T. 13 S., R. 36 E., M. D. M., 4 miles east of Citrus, a station on the Southern Pacific Railroad; elevation 7500 ft. Owners are George F. Lund and J. W. Thompson, Los Angeles.

A quartz vein occurs on the contact of dolomite and granite. The vein strikes NE. and SW., dip 75° SE.; width 12 in. to 3 ft. Development consists of a tunnel driven southwest along contact for a distance of 120 ft. and 1500 ft. southwest of the tunnel is an incline shaft sunk on contact to a depth of 200 ft.; also a crosscut tunnel to contact 30 ft. in length. The vein is mineralized with iron oxides and copper carbonates, with values in gold and silver. Scheelite occurs along bedding planes in limestone on cross fractures.

Keogh Group of 9 claims is in the Coso Mountains, T. 20 S., R. 39 E., M. D. M., some 7 miles a little west of south from Darwin; elevation 7000 ft. Owners are J. J. Rogers, 218 North Fairview Ave., Burbank, Calif. and Wm. G. Tait, 823 South Hauser Blvd., Los Angeles. The property is being developed by Rogers and David Blaine.

The rock exposures on this property are largely granitic, probably granodiorite, with some thin beds of metamorphosed limestone. These altered limestones (tactite) have a general E.-W. strike and, where cut by north-south cross fractures, carry scheelite in sufficient quantity to constitute an ore of that mineral. The gangue is practically a solid mass of garnet and epidote, the latter frequently occurring as coarse crystals. Composite samples from the outcrop and two or three shallow surface cuts have shown from 5% to 6.18% WO_3. Lengths of these ore shoots have not yet been determined.

Principal development to date consists of a shallow surface cut which indicates a width of ore of about 10 ft. at this point. Over the hill south of this cut some 1200 ft., is a massive outcrop of the same character of ore. This outcrop has a width of 8 ft. to 10 ft. for a length of about 40 ft. Its strike is also E.-W. No work has been done here. In the wash below and to the southeast of this outcrop, two large boulders (about 3 tons each) of brown garnetite have been found. Samples of these boulders are said to have shown 5% WO_3. No other pieces of similar float have been found nor has their source been located.

Operators are now completing a road into the workings and moving in a portable compressor. Three men are working.

Little McGee Creek Tungsten Mine comprises 6 claims situated on Little McGee Creek, in Tungsten Hills District, in Sec. 13, T. 7 S., R. 31 E., M. D. M., 8 miles west of Bishop. Owner is McCloskey Mines, Inc., E. F. McCloskey, president; A. B. McCloskey, secretary, 14926 Alva Drive, Pacific Palisades, Calif.

Tactite occurs along a contact of limestone and quartz diorite. The ore consists of scheelite in a gangue of garnet, quartz and epidote. Development consists of a tunnel 135 ft. in length, driven 300 ft. below the outcrop. It is stated that there is 500 tons of ore on the dump, assaying 1% WO_3. They plan to ship this ore to the Mineral Reduction Company's mill at Benton for treatment. Ten men are employed on development.

Mountain Kid Group of 3 claims is 1½ miles west of old Coso, in T. 20 S., R. 39 E., M. D. M., about 9 miles southwest of Darwin; elevation 6500 ft. Owner is Paul Wilbur, 253 Richland Ave., Glendale, Calif.; under lease to West Coast Tungsten Co., C. E. Cord, 9730 Wilshire Blvd., Beverly Hills, Calif.

The deposit occurs at the contact of limestone and granite. The lessee has sunk a shaft 38 ft. deep and on the 30-ft. level drifted east 12 ft. and west 40 ft. The west drift was turned south and cut an orebody 17 ft. wide said to carry 1.16% WO_3 An incline tram about 300 ft. long has been built from shaft collar to bins in the bottom of the canyon.

The property is equipped with Ingersoll-Rand portable compressor and gasoline hoist. Three men are working.

Pacific Tungsten Co., E. L. Cord, president and owner, Darwin, Calif., has leased the St. Charles, Hayward and Fernando groups of claims from C. W. Fletcher and associates. These groups comprise some 25 claims, 9 of which are patented, in Sec. 24, T. 19 S., R. 40 E., M. D. M. They are situated from one to two miles east and south of Darwin; elevation 4600 ft.

On these claims, except at the west end of the St. Charles, only sporadic outcrops of the intrusive granitic rocks may be seen in the altered limestones. The deposits now being worked occur either in cross-fractures or along the bedding of the silicified limestone. The gangue consists largely of epidote, green garnet and some calcite. in which occurs scheelite and some powellite (calcium molybdate). Formerly some lead ore was shipped from the Fernando which carried galena, cerusite and anglesite in a jasper, hematite, limonite and calcite gangue.

The widths vary from about 2 ft. in the bedding, where such streaks of ore are separated by silicified limestone, as on the St. Charles, to 20 ft. or more in the Durham. The average grade of the ore is about 0.90% WO_3.

The ore is hauled by truck, and concentrated in the mill of the former Keeler Gold Mines, Inc., at Keeler.

St. Charles Mine is about one mile east of Darwin. The ore occurs as streaks in the silicified limestone near its contact with the quartz diorite. The general strike here is NE.-SW., dip about 80° NW. The ore is from 2 ft. to 8 ft. wide. Shoot is opened for a length of 120 ft.

Development consists of 150-ft. shaft with two levels. The top, 0 Level, as it is called, is about 50 ft. below the shaft collar. It is an adit, driven as a crosscut northwest 20 ft. to the vein, with drifts northeast 30 ft. and 210 ft. southwest. There is a raise to the surface at 195 ft. southwest of shaft. On 121-ft. level, drift 55 ft. southwest, 95 ft. northeast. Stoped above tunnel level for a length of 100 ft.

On the *Hayward*, some 260 ft. southeast of above-mentioned shaft, there is a glory hole about 100 ft. long and 30 ft. wide. They are sinking a shaft in the floor of this glory hole at its northeast end. Shaft is 30 ft. deep.

At this property, the ore is screened to $\frac{3}{8}$ in. and the oversize sorted for shipment to the mill, together with the fines.

The *Fernando Mine* is approximately one-half mile south of the St. Charles. On this property, the ore occurs in two intersecting veins. The Fernando is a larger cross-fracture, while the Durham is a deposit in the bedding of the tactite. The Fernando strikes N. 65° E., dipping steeply about 75° to the SW. The Durham strikes N. 15° W., dipping 67° W. The ore shoot on the Durham is 400 ft. long, its northern limit being the Fernando vein and a parallel fault fracture marks the southern end. As stoped, it is up to 24 ft. wide, averaging about 10 ft. in width. The Durham vein has been developed by a shaft 250 ft. on 67°, with levels at 90 ft. and 200 ft. below the adit which is approximately 50 ft. below the shaft collar. The adit is driven south on the vein 215 ft. Of this length, 120 ft. has been stoped to surface, 10 ft. to 20 ft. wide. The 100-ft. level has been driven north 230 ft. to the Fernando vein and south 260 ft. to the fault. At 20 ft. south of the shaft is the north end of a stope 140 ft. long and about 35 ft. high where mining is now in progress. Raises have been driven from 90-ft. level to adit at 25, 55, 80 and 110 ft. south of the shaft; also at 75 and 135 ft. north of the shaft. At 200 ft. north of the shaft there is a raise 40 ft. On the 200-ft. level, a drift has been driven south 75 ft.

The Fernando vein has been developed by an adit driven west 655 ft. which connects with new shaft now sinking at 70 ft. from the portal. This shaft, sunk on an inclination of 80°, is (Nov., 1941) 125 ft. deep. In the adit at 135 ft. from the portal crosscut northeast 70 ft.; at 210 ft., north 50 ft.; at 310 ft., northwest 120 ft.

Each of these shafts is equipped with a 30-h.p. electric hoist. At the old shaft there is an Imperial Type 10, Ingersoll-Rand compressor, driven by 100-h.p. motor which also supplies air for the St. Charles and Hayward mines. Fifty-five men are employed.

Bibl.: State Mineralogist's Reports XXII, pp. 484-485; XXXIV, pp. 440 and 560-561.

Panyo Tungsten Mine. It comprises 5 claims, situated in the Coso Mountains, in T. 20 S., R. 40 E., M. D. M., 4 miles south of Darwin, and 4 miles northeast of Coso; elevation 4800 ft. Owner is Walter Sorensen, Darwin; under lease to K. A. Walkins, Darwin, Calif.

Scheelite occurs in tactite on contact with granite, and is disseminated in garnetiferous gangue, associated with molybdenite and powellite, calcium molybdate. The strike is E.-W., with a dip of 45° S. Width varies from 6 ft. to 10 ft.

On west end of claims the development consists of an open cut 50 ft. in length and 12 ft. in depth. On the east end of claim, development consists of open cut and 2 tunnels 40 ft. in length below open cut. Shipped 160 tons to El Diablo Mining Company's mill.

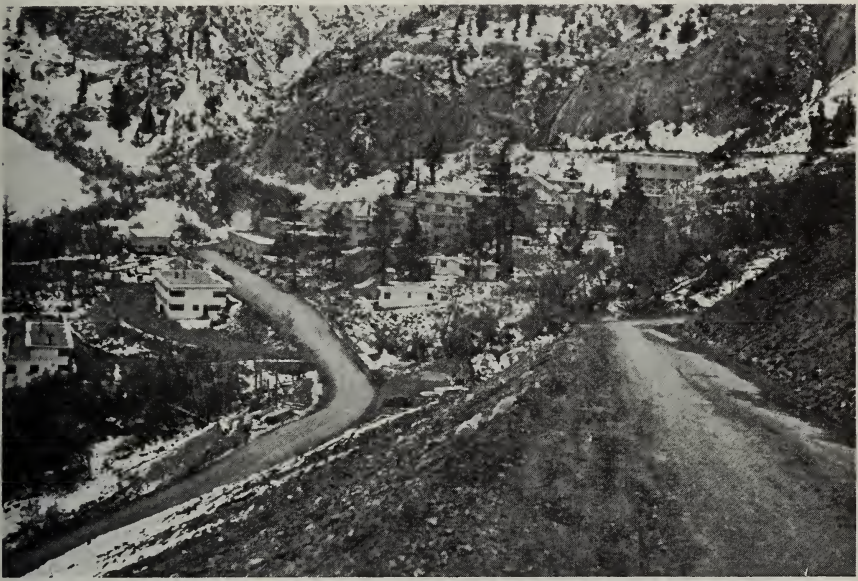
Pine Creek Tungsten Deposit, consisting of 12 claims, is situated on Mt. Morgan, in T. 6 S., R. 30 E., M. D. M., 21 miles west of Bishop; elevation 10,800 ft. to 12,000 ft. Owner is United States Vanadium Corp.; local address, Bishop, Calif.; general offices, 30 E. 42d St., New York; J. R. Van Fleet, vice president and general manager; Blair Burwell, general superintendent; M. N. Shaw, superintendent; J. V. Galloway, mill superintendent; K. G. Link, mine superintendent.

The deposit is of the contact metamorphic type, occurring between a dolomitic footwall and a granite hanging wall. Its strike is N.-S. Width varies from 15 ft. to 60 ft. The valuable minerals are scheelite, molybdenite and chalcopyrite, with which are associated some gold and silver. These occur in a garnetiferous-epidote gangue. In general, the higher scheelite values occur near the footwall while molybdenite is more abundant near the hanging wall. Average values in the ore are 0.7% to 1.5% WO_3, 1% MoS_2, 1% Cu, ½ oz. Ag, and 0.01 oz. gold.

Looking south toward Pine Creek from upper (No. 4) open-pit (elevation 12,000 ft.) of U. S. Vanadium Company's mine, Inyo County. *Photo (Oct. 26, 1941) by Walter W. Bradley.*

Development consists of crosscut tunnel, haulage level, elevation 10,800 ft., driven N. 30° E., 2500 ft. to contact, thence drift south 300 ft. and north 5800 ft. Two orebodies, having an aggregate length of 1800 ft., with a barren zone of 200 ft., between, have been developed. The south orebody, having a length of 600 ft., has been split into east and west branches by a horse of dolomite. The north orebody, from 80 ft. to 125 ft. wide, is 1200 ft. long. A sub-level caving system of mining is used. Between the haulage or A level and the glory holes on the surface, there have been driven four sub-levels, B, C, D and E. The vertical distance between the haulage level and the glory holes is approximately 600 ft. Long diamond-drill holes are used in undercutting the blocks above the sub-levels.

Ore is hauled through the A level to the crushing plant at the head of an aerial tram, by 5-ton storage-battery locomotives, in 10-car trains. The cars, 3-ton capacity, are of the side-dump type. It is delivered to 20-in. Symons cone crusher, crushing to 4 in.; capacity 160 tons per hour, to 1000-ton coarse-ore bin at tram terminal. From the bin, it is conveyed to the mill by a 3-section, aerial tram, 11,000 ft. in length being supported by 14 towers. The tram capacity is 100 tons per hour; discharge into bin from which a pan feeder delivers the ore to Symons cone crusher, the product of which is $\frac{3}{8}$ in.; elevated to Symons $\frac{3}{8}$ in. vibrating screens; 36 in. belt conveyor to four 1200-ton crushed ore bins; oversize from screens returned to crusher. From fine-ore bins, conveyors deliver ore to 4 No. 65 Marcy ball mills, open-end type, each in closed circuit with 54-in. Aikens classifier, each of these units being driven by 100-h.p. motor. Ball mills grind to 98% through 65 mesh which is the flotation feed. The feed pulp contains 25% solids. Flotation floor is divided into four separate sections of three 10-cell, 18-in. impeller type, Minerals separation machines. The following reagents are used to make a bulk concentrate: Sodium silicate, pine oil and xanthate. This concentrate contains 20% MoS_2, 20% Cu and 30 oz. Ag. It is then treated with steam to remove the flotation reagents and the molybdenite and copper-silver minerals are separated in a flotation circuit by the use of cyanide, as a reagent which depresses the chalcopyrite. The tails from the first four flotation sections are divided and sent to two other sections where cresylic acid, emulsol and sodium



New 1400-ton mill of U. S. Vanadium Company on Pine Creek, Inyo County.
Photo by Walter W. Bradley.

oleate are added to float the scheelite. Tails from these cells go to 12 Diester tables. Scheelite concentrates from flotation machines and tables go to chemical plant where they are treated, under pressure, with steam and soda ash and precipitated as sodium tungstate.

The plant has a capacity of 1400 tons per day. Four hundred men are employed.

> Bibl.: State Mineralogist's Reports XVII, pp. 301-302; XXII, pp. 511-512; XXXIV, pp. 465-466; XXXVII, pp. 295-296; U. S. G. S. Bull. 725, p. 273; P. 110, p. 124.

Shorty Harris Tungsten Mine comprises 2 claims situated in T. 15 S., R. 41 E., 3 miles south of Goldbelt Spring, 10 miles east of Dodd Spring in the Ubehebe Mining District and 55 miles west of Furnace Creek Ranch; elevation 6000 ft. Owners are Bert Hunter, Olancha, Calif. and E. G. Mason, Los Angeles.

Tactite occurs on contact of granite and dolomite. It is reported that outcrop can be traced on the surface for 1000 ft.; quartz, garnet, epidote, mineralized with scheelite. In 1917 Shorty Harris mined and shipped $1,500 worth of ore.

Development consists of open cuts and short tunnel 20 ft. in length.

West Coast Tungsten Co., C. E. Cord, owner (not a corporation), 9730 Wilshire Blvd., Beverly Hills, Calif., has a lease on the mill formerly operated by the Keeler Gold Mines, Inc., T. 17 S., R. 38 E., M. D. M., 4 miles southeast of Keeler; elevation 4500 ft.

This was originally a cyanide plant for the treatment of gold ore. The present operator has converted it into a mill for the concentration of scheelite from ores mined largely in the Darwin district.

The plant now consists of four 40-ton bins; belt feeder to 9 in. by 16 in. jaw crusher; $\frac{3}{8}$ in. vibrating screen; over size to 20-in. TY

West Coast Tungsten Co. mill at Keeler, Inyo County. *Photo by Walter W. Bradley.*

Traylor crusher; undersize from ⅜-in. screen to two 100-ton, fine-ore bins where it is joined by Traylor crusher product; belt feeder to 30-in. by 14-in. rolls, in closed circuit, by means of elevator, with 10 to 16-mesh vibrating screen; undersize to Denver duplex 16-in. by 24-in. jig, to Overstrom Universal tables, the third table treating middlings from the first two; to drag classifier; slimes to 30-ft. Dorr thickener; sands and thickened pulp to tails; concentrates to rotary drier (dried at 900°); thence, to Stolle electrostatic separator. Capacity is 130 tons per day. The bulk of the 15,000 tons treated has come from the properties of the Pacific Tungsten Co., at Darwin.

Sixteen men are employed.

KERN COUNTY

C. & H. Mining & Milling Co. (fictitious name), Daniel Cronin and Bernard Harrington, Bakersfield, Calif., have acquired the mill at Weldon and they are operating it as a custom plant to treat the ores of this district.

The mill consists of bin, Comet gyratory crusher, elevator to vibrating screen, oversize to Kue-Ken, Straub balanced crusher to elevator, to bin; conveyor to vibrating screen to 2 Denver jigs, to 2 Plat-o tables to one cleaner table. Machines have individual motor drives. Capacity about 75 tons per day.

Four K. Tungsten Mine. It comprises 2 claims and a patented mill site on Clear Creek, in Sec. 26, T. 27 S., R. 32 E., M. D. M., 3 miles north of Havilah; elevation 3600 ft.; H. J. Kutzner, Bodfish, Calif.

Two parallel quartz veins occur in granite on ridge east of Clear Creek. Veins strike N. 10° E. to N. 20° E., dip 70° E. Widths vary from 2 ft. to 6 ft. An open cut on the west vein to a depth of 6 ft. and 20 ft. in length exposes a vein of quartz about 4 ft. in width mineralized with scheelite crystals. About 10 tons of ore extracted are reported to carry 1% to 3% WO_3. Three men are employed.

General MacArthur Group of Tungsten Claims comprises 2 claims situated in the SW¼ SW¼ Sec. 2, T. 10 N., R. 15 W., and Sec. 14, T. 10 N., R. 15 W., S. B. M., on ridge west of Gamble Canyon, in the Tehachapi Mountains, 3 miles east of White Oak Lodge and 20 miles west of Mojave. Owner is L. M. Allen, 609 Alexander Street, San Fernando, California.

Gwynne & Jennette Mines (gold). The property comprises 445 acres of patented mining claims, situated in Green Mountain Mining District, in Sec. 21 and 22, T. 29 S., R. 34 E., M. D. M., 25 miles northeast of Caliente and 3 miles northeast of Piute; elevation 7500 to 8000 ft. Owners are Otto and Jack Geringer, Mojave, Calif.

Scheelite occurs in gold quartz veins on Gwynne and Kersey claims. The Gwynne vein strikes E.-W. and dips 40° S. Width varies from 12 in. to 2 ft. The vein quartz shows free gold associated with pyrite and some scheelite. The Kersey vein strikes N. 35° E., dips 40° S. Width varies from 2 ft. to 4 ft. Vein quartz shows free gold associated with pyrite; also scheelite. The Gwynne vein is developed by an incline shaft 300 ft. in depth and a tunnel driven on the vein for a distance of 1750 ft. The Kersey vein which is southeast of the Gwynne vein, is developed by a tunnel driven on the vein for a distance of 600 ft. The ore is treated in a 25-ton amalgamation and concentration plant. The scheelite is recovered on Wilfley tables. Six men are employed.

Ideal Group Tungsten Mines. It comprises 4 claims known as Ideal No. 1, No. 2, No. 3, No. 4, situated in Sec. 20 and 21, T. 25 S., R. 32 E., M. D. M., on Slick Creek, on the Alta Sierra Road, 14 miles east of Glennville. Owner is J. C. Rook, Glennville, Calif.

On the ridge northwest and southeast of Slick Creek, there is a massive outcrop of tactite on contact of granite and limestone about 100 ft. in width which can be traced on the surface for several thousand feet. The tactite strikes NW.-SE. and scheelite occurs with garnet, epidote and quartz. Developed by open cuts and shallow shafts.

On Ideal Claim No. 2, there is an open cut 50 ft. in length, 15 ft. deep and 15 ft. in width. Sierra Tungsten Co. mined and milled 100 tons of ore from the open cut reported to have assayed from .5% to 1% WO_3, from which is reported 1½ tons of concentrates, carrying 70% WO_3. Idle.

Locarno-Simon Group of Mines (gold-tungsten). The property comprises 160 acres (patented) located in the SE.¼ of Sec. 21 and 6 claims located in Sec. 28, T. 29 S., R. 34 E., M. D. M., in the Green Mountain Mining District, on the west slope of the Piute Mountains, 25 miles northeast of Caliente. Owner is N. V. Franceschi, Caliente, Calif. The property adjoins the Gwynne Mine on the west; elevation 7000 to 7500 ft.

Two quartz veins occur in granite. One strikes NE.-SW. and dips 40° S. The other strikes N.-S. and dips 50° E. Widths of veins vary from 2 ft. to 4 ft. The vein quartz is mineralized with gold, associated with pyrite and scheelite. Some high-grade scheelite occurs in bunches which has been sorted out for shipment; reported to assay 60% WO_3.

Development consists of 3 tunnels 100 ft. to 300 ft. in length on northeast-southwest vein and 3 open cuts on north-south vein.

Equipment consists of 25-ton Huntington mill, amalgamation plates and concentrating table. Two men employed on development work.

Mintern Group of Tungsten Claims comprise 6 claims in Sec. 24, T. 25 S., R. 33 E., M. D. M., 2½ miles northeast of Kernville; elevation 3750 ft. Owners are C. C. Mintern and C. G. Pasley, Glennville, Calif.

Scheelite occurs in tactite along contact of dolomite and granite, the strike being NW.-SE.; width 25 ft. Mineralization extends for a length of 75 ft. Scheelite also occurs in a quartz-feldspar dike that strikes E.-W.; dip 40° S. Width varies from 6 ft. to 8 ft.

Development consists of shallow open cuts. Samples taken from surface exposures are reported to carry from 0.5 to 1% WO_3. Three men are employed on development.

Monarch Rand Mine comprises three 60-acre claims situated in Rand Mining District, in Sec. 1 and 12, T. 30 S., R. 40 E., 1½ miles southeast of Randsburg; elevation 3600 ft. Owner is Monarch Rand Mining Co., S. O. Walker, president and manager, Randsburg, Calif.; under lease to Holcomb Valley Mines Co., c/o Lacy Manufacturing Co., 973 North Main St., Los Angeles; George N. Knudsen, president and manager. They are installing screening and concentration plant; capacity 300 cu. yd. per 24 hr. for recovery of gold and tungsten values. Ten men are employed.

Mountain View Tungsten Mine. It comprises 3 claims located on the north slope of Piute Mountain, in Sec. 26, T. 29 S., R. 33 E., M. D. M., 4 miles south of Havilah; elevation 4000 ft. Owners are George Ramey and H. D. Hicks, Bodfish, Calif.

Scheelite occurs in a garnetiferous gangue on contact of dolomite and granite; strike N. 20° W., dip 70° NE.; width 8 ft. to 12 ft. Developed by a tunnel 40 ft. in length. West of tunnel workings, there is an open cut 10 ft. in depth and 30 ft. in length. The ore extracted from these workings is reported to carry 1% to 2% WO_3. From tunnel level to 10-ton ore bin in canyon, there is a jig-back tram 700 ft. in length. Six men are employed.

Owl Mine, Brook Woods, Glennville, Calif., owner, is under lease and option to Sierra Tungsten Co., Cecil R. Smith and L. R. Harris, Los Angeles. The property is situated in a canyon about 2½ miles by road west of Summit Lodge and three-quarters of a mile north of the Glennville-Kernville road, in Sec. 17, T. 25 S., R. 32 E., M. D. M., 12 miles northeast of Glennville.

The ore occurs in irregular bunches along a granitic-limestone contact. The gangue is tactite and the position of the lenses of ore seems to be fixed by cross fractures. The contact in general, strikes N.-S.; the cross fractures NW.-SE.

In the canyon the deposit has been developed by 3 tunnels driven south, each about 100 ft. long and 40 ft. vertically apart. The upper tunnel is caved. In the middle tunnel, two raises each 30 ft. high have been driven. At the portal of this tunnel, a surface cut some 30 ft. long, 15 ft. wide and 20 ft. high has been made. The ore here occurred as two streaks, each about 4 ft. wide and separated by 8 ft. of crystalline limestone. The lower tunnel is at the same elevation as the top of the mill which is some 200 ft. north of the portal.

On a ridge about 3000 ft. northeast of these workings, an open cut some 125 ft. long, 15 ft. wide and benched to a height of about 50 ft., has been made along a similar contact, the strike of which is east of north. These workings are about 500 ft. above the mill. It is reported that 2500 tons were hauled to the mill from this open cut.

The mill consists of bin, jaw crusher, vibrating screen, 4-ft. by 4-ft. ball mill; oversize by elevator back to crusher; 2 concentrating tables. Concentrates are cleaned in a combination drier and electrostatic separator.

Idle. Was shut down October 1, 1941.

Pine Tree Mine, comprising 4 claims, is an old gold property, in the Tehachapi Mountains, in Sec. 4, T. 11 N., R. 15 W., about 6 miles north of Tehachapi.

Here, scheelite occurs in quartz veins in the granodiorite. The strike is approximately N. 65° E., dip 25° to 30° SE. Widths vary up to 3 ft. Scheelite appears to occur sporadically in the veins near cross fractures or step faults which show only a very few feet displacement.

Development consists of an old tunnel reported to be 600 ft. long, now caved at 65 ft. from the portal. About 500 ft. west of this tunnel, an inclined shaft has been sunk 65 ft. on the vein. Scheelite occurs in this incline for a few feet, being about 18 in. in width. An open cut has been made on a vein 1200 ft. east of the incline. The cut is 30 ft. long and about 3 ft. deep. Some pieces were taken from this trench which showed good scheelite values across a width of about 6 inches.

The owner has built roads to the various outcrops and has constructed two modern cottages at the site of the old gold mill. Two men are working.

Scheelite is reported [2] "scattered along a 10-mile strip and 3000 feet wide in places, located from Nine Mile Canyon to Homestead Service Station west of Inyo-Kern."

Summit Lime Company, Whittier, Calif., has 5700 acres of land, largely in T. 11 and 12 N., R. 15 W., S. B. M., some 3 to 5 miles south of Tehachapi. A mineral rights lease has been granted by this company to Vernon Bettin, Rives-Strong Bldg., Los Angeles, who is prospecting the ground for scheelite.

A quartz vein in the granodiorite, strike N. 60° W., dip 45° SW., from 6 in. to 12 in. wide, has been trenched for a length of 15 ft. Where two flatly dipping stringers about 2 in. wide intersected the vein, 900 lb. of high grade was extracted and shipped. This ore returned approximately 50¢ per pound.

One man is prospecting the property for the lease holder.

Tungsten Big Lode Group comprises 3 claims situated in Secs. 11 and 14, T. 27 S., R. 34 E., M. D. M., 5 miles south of Weldon, California. Owner is Ferro-Tungsten Alloys, Ltd., H. W. Daley and George Munson, Isabella, California.

Tungsten Chief Mine. The property comprises 7 claims situated on the southwest slope of Piute Mountains, in Sec. 26 and 27, T. 28 S., R. 32 E., M. D. M., 5 miles south of Havilah. Owners are T. J. McKee and N. T. McKee, Caliente, Calif. The McKee brothers started operations on these claims in July, 1940. The claims are located 3 miles north of the mill, the latter being located on the McKee Ranch in Sec. 3, T. 29 S., R. 32 E.

A series of quartz veins occurs in granite, strike N. 40° to 50° E., dip 50° to 60° NW. The veins have limestone as hanging wall with granite as the footwall. The veins vary in width from 6 ft. to 8 ft. The vein quartz is mineralized with scheelite and garnet, and the ore mined varies from 0.5% to 2% WO_3.

Development: On a vein which strikes N. 50° E. and dips 60° NW., No. 1 shaft has been sunk to a depth of 50 ft. and about 500 ft. northeast of this shaft, No. 2 shaft is being sunk as a 2-compartment shaft 50 ft. below tunnel level. A tunnel was driven on the vein for a distance of 85 ft. where ore was cut off by a fault. The vein is 6 ft. to 8 ft. in width; strike N. 50° E., dip 60° NW. Ore shoot developed is 85 ft. in length and reported to carry .5 to 2% WO_3.

Mine equipment consists of 12-h.p. LeRoi gas-driven hoist; Chicago pneumatic compressor, 300-cu. ft. capacity.

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[2] Mineral Notes and News, The California Federation of Mineralogical Societies, Bull. 55, April 1942.

About 200 ft. in elevation above No. 2 shaft, at Clay level workings, a crosscut tunnel is driven north 100 ft. At 80 ft. from portal, cut vein which strikes N. 45° E., dip SW.; 6 ft. to 8 ft. wide. The footwall is limestone with granite as hanging wall. Ore shoot developed is 40 ft. in length. Ore mined is reported to carry .7% to 2% WO_3. From this tunnel level, a raise has been put up 80 ft. to glory hole on surface on a parallel vein. About 2000 ft. northeast of these workings, there is a quartz vein up to 40 ft. in width between a granitic hanging wall and a green schist footwall. The ore appears to occur in pods in this mass of quartz, its presence being indicated by pink quartz. A tunnel has been driven here 50 ft. southwest and ore up to 10 ft. in width removed. This tunnel produced $13,000.

The concentration plant has a capacity of 25 tons per day. Mine run of ore to 30-ton ore bin, then to 6-in. by 8-in. crusher, from fine-ore bin, to belt feeder to Wheeler ball mill, to revolving screen, screening to 16-mesh; oversize returned to ball mill; minus 16-mesh material to Diester Plat-o table. Concentrate cut runs 65% to 70% WO_3. Concentrates panned to eliminate garnet gangue. Mill is driven by 25-h.p. Fairbanks-Morse gas engine. Plan to increase capacity of the mill by installation of Wheeler ball mill, with a capacity of 2 tons per hour; also two more concentration tables. Six men are employed.

Tungsten Hill Mine comprises 12 claims located in Sec. 3, T. 28 S., R. 32 E., M. D. M., 1½ miles northwest of Havilah. Owners are T. M. Smith and E. E. Lambert, Havilah, Calif.

Tactite occurs on contact of dolmite and granite. Scheelite occurs in quartz and epidote; strike N. 20° W., dip vertical. Width of ore said to be 8 ft. to 16 ft. Development consists of several open cuts. Samples from open cuts are reported to assay 1% to 2½% WO_3.

Two men employed on development work.

Tungsten Queen Group of Mines comprises 3 claims situated on the southeast slope of Greenhorn Mountains, Secs. 30, 31, T. 25 S., R. 33 E., M. D. M., 2 miles west of Kernville. Owner is Mintern Estate, Bakersfield, California; under option to Ferro-Tungsten Alloys, Ltd., H. Milton, W. Daley, and George Munson, Box 696, Isabella, California.

United States Flare Corporation, c/o 1115 Pacific National Building, Los Angeles, is developing a tungsten prospect four miles northwest of Inyo-Kern; Norman Whitmor, Los Angeles, Superintendent. There are two patented claims and 14 not patented; and 10 men are employed. A mill is planned.

Williams Ranch Tungsten Deposit. The property comprises 160 acres situated in the east end of Walker Basin, on the south slope of the Piute Mountains, in Sec. 16, T. 29 S., R. 33 E., M. D. M., 8 miles southeast of Havilah; elevation 4000 ft. Owner is Nick Williams, Caliente, Calif.; under lease to J. E. Hicks, Niland, Calif. and J. A. Durnal, Bakersfield, Calif.

On ridge one mile northeast of the Cal Walsher Ranch, there are two outcrops of tactite which strike N.-S. to N. 30° W. These outcrops are from 20 ft. to 30 ft. in width and 200 ft. in length. The formation is granite and schists. Scheelite occurs in quartz-garnet-epidote rock. A number of shallow trenches and prospect shafts have been sunk in these outcrops and the ore extracted is reported to assay from .5% to 1.5% WO_3. Two men are employed on development.

MADERA COUNTY

J. E. Cobb property, comprising 6 claims, is near north line of Sec. 1, T. 5 S., R. 24 E. and Sec. 6, T. 5 S., R. 25 E., M. D. M., north of Clover Meadow in Jackass Mining District; elevation 7500 feet. Owner is J. E. Cobb, Box 574B—Route #1, Fresno, California.

The deposit is undeveloped except for assessment work and is one mile from existing road. Good showings of scheelite have been found in a gangue of olivine, epidote and quartz.

Deposit will not be accessible until spring on account of snow.

R. and M. Tungsten Mines (S. S. Rapp of Coarsegold) reports shipping scheelite ore to a custom mill from the Jones mine, Secs. 24 and 25, T. 7 S., R. 20 W., and Sec. 30, T. 7 S., R. 21 W., M. D. M., during 1941.

Tin Bucket No. 2, comprising one claim, is in Sec. 7, T. 6. S., R. 22 E., M. D. M., near Sugar Pine; elevation 5000 ft. Owners are J. E. Hassack and wife, North Fork, Calif.

The deposit, reported to be 5 ft. to 10 ft. wide and traceable for several hundred feet, occurs at the contact of granite and altered limestone. The gangue is garnet and quartz with some epidote. Some samples are said to carry up to 4% scheelite. Only assessment work has been done. Hassack reports that this deposit continues stronger and richer into the adjoining patented, but undeveloped, land of the California Institute of Technology (Pasadena).

Walker Tungsten Mines, Inc., L. C. Thornton, president, 646 Michigan St., Fresno, Calif., and Frank J. Stefanich, 959 Farris St., Fresno, Calif., is reported to have 10 claims on Chiquita Creek, 20 miles north of Bass Lake, on the north slope of Jackass Mountain, 80 miles northeast of Fresno; elevation about 7000 ft.

The deposit is said to be on a contact of limestone and granite. It is traceable by means of sporadic outcrops for a distance of 1000 ft. and varies in width up to 20 ft. The gangue is largely garnet and epidote. Samples are said to assay 1.5% to 5%. Development consists of one open cut 35 ft. long by 20 ft. wide.

Deposit will not be accessible until spring on account of snow.

MARIPOSA COUNTY

Big Grizzly Group of Claims, comprising 5 claims, is located on Nibs Gulch, Hite Cove Mining District, in Sec. 17, T. 3 S., R. 19 E., M. D. M., one mile northwest of Clearing House, on the Merced River, and 16 miles north of Mariposa. Owner is James H. Metzler, Incline, Calif.; elevation 1600 ft.

These claims are located on the East Belt of the Mother Lode of California. J. W. Warford, Mining Engineer, Mariposa, Calif., in his report on the property, states that the gold quartz veins on these claims are mineralized with scheelite. He states that there are six parallel quartz veins striking N. 45° W. and varying in dip from 30° to 70° NE.

They occur in granite. He states that scheelite crystals up to $\frac{3}{8}$ in. were noted in the quartz. The veins of quartz vary in width from 12 in. to 3 ft. Development consists of open cuts and short tunnels.

MONO COUNTY

Scheelore Tungsten Mines. The property comprises 8 claims known as Scheelore Group, located south of Mt. Baldwin, at the headwaters of McGee Creek, T. 5 S., R. 29 E., M. D. M., 10 miles south of McGee Creek Resort on Highway 395 and 40 miles northwest of Bishop; elevation 11,000 to 12,000 ft. Owners are H. A. Van Loon and J. E. Morhart, Bishop, Calif.

Three tactite exposures mineralized with scheelite occur on contact of granite and marbleized limestone. These orebodies are known as No. 1, No. 2 and No. 3. No. 1 orebody strikes N.-S. and is 200 ft. in length and 10 ft. to 30 ft. in width. Northwest of No. 1 orebody is No. 2 orebody which is 100 ft. in length and strikes E.-W. It occurs on contact of granite and tactite and is 15 ft. to 30 ft. in width. No. 3 orebody is 2000 ft. northwest of No. 2 orebody. This orebody strikes NW.-SE. and occurs on contact of granite and marbleized limestone. It is about 10 ft. to 30 ft. in width. Here the scheelite occurs in quartz. Samples taken from the above-mentioned orebodies are reported to carry from .5% to 2% WO_3.

The present work is confined to No. 3 orebody which consists of sluicing slide material into a plant equipped with screens and jigs, with a capacity of 100 tons per day. They are producing concentrates reported to assay 60% to 70% WO_3. Six to 8 men are employed.

Scheelite is reported by Arthur W. Hoge, Nevada City, as occurring on the Sierra Nevada summit in Sec. 19 and 30, T. 4 N., R. 22 E., southwest of Bridgeport.

PLUMAS COUNTY

Grizzly Tungsten No. 1. This is a new prospect in Sec. 11, T. 23 N., R. 5 E. consisting of one claim located March 11, 1942 by C. B. Goodrich. Leased with option to J. P. Branley, Greenville. The claim is on the Feather River highway close to the Butte County line.

Country rock is a gray to black hornblende schist which rises steeply from the highway. A granitic rock probably granodiorite invades the schist in many places and dikes of syenite are common.

The portal of the discovery adit is about 150 feet above the highway and is run on the contact of the schist for 13 feet. The face and walls are metamorphic in character and show actinolite, fine to coarse garnets and quartz. Specks of tan-colored scheelite occur in the metamorphosed rocks and in seams in the schist. No assays have been made as yet to determine the grade of the ore. There are other metamorphosed zones showing garnet and wide bands of crystalline calcite which may also carry scheelite. Lack of dump room will handicap development.

RIVERSIDE COUNTY

Blue Boy & Black Mountain Group of Tungsten Claims. It comprises 4 claims known as Blue Boy, Blue Boy No. 1, Black Mountain and Black Mountain No. 1, situated in the San Jacinto Mountains, one mile west of Twin Pines Ranch, in Sec. 3, T. 4 S., R. 1 E., S. B. M., 8 miles south of Banning, Calif.; elevation 3500 ft. Owner is J. O. Mayall, Santa Ana, Calif.

On Blue Boy claims, an outcrop of tactite occurs in schist; strike E.-W., dip 40° S.; width 2 ft. to 4 ft. Length of outcrop along its strike is approximately 50 ft.

Development consists of open cut 12 ft. in length and 5 ft. in depth. Eight tons of ore was extracted from these workings reported to average 1% WO_3. Vein material consists of garnet, epidote and schist mineralized with scheelite. On Black Mountain claims there are small exposures of tactite in schist; strike NE.-SW., width being from 2 ft. to 4 ft. and length of exposure on surface not over 30 ft. On Black Mountain No. 1, development consists of open cut 20 ft. on length and 6 ft. in depth. On Black Mountain No. 2 claim, there is a shaft 10 ft. deep, sunk on tactite outcrop 20 ft. in length and 4 ft. in width. Twelve tons of ore extracted from these two workings is reported to have assayed 6% WO_3.

Garnet Queen Tungsten Mine. It comprises 3 claims situated on the west slope of the Santa Rosa Mountains, in Sec. 20, T. 7 S., R. 5 E., S. B. M., 30 miles southwest of Indio; elevation 6000 ft. Owners are Jack Pyster, Coachella, Calif., and Ogden Mayall, Santa Ana, Calif.

A belt of schist occurs in granite and Garnet Queen vein occurs in schist; strike N. 80° E., dip 70° S.; width 2 ft. to 6 ft. The vein material is garnet, epidote and quartz, mineralized with scheelite. Ore milled is reported to assay .7% to 1% WO_3.

Development consists of an oppen cut along vein for a distance of 50 ft. and 8 ft. to 10 ft. deep. This vein can be traced on the surface for a distance of 1500 ft. In 1896, south of these workings, a shaft was sunk to a depth of 50 ft. on quartz stringers in schist reported to carry values in gold.

In 1941, a small concentration plant was installed by Elliott and associates of Glendale, Calif., capacity of plant being 10 tons per day.

Mill: Blake crusher 6 in. by 8 in., to bucket elevator, elevated to shaking screen 16-mesh, oversize from screen to Elliott impact mill, minus 16-mesh material to Elliott jig, then, to 2 Elliott concentrators. It is reported that 10 tons of ore treated in mill produced a concentrate carrying 60% WO_3 which was sold for $250. Owners are remodeling mill and have 3 men employed on development work.

Magnesium Canyon Tungsten Mine, comprises 3 claims, known as Cottonwood No. 1, Cottonwood No. 2 and Cottonwood No. 3, situated in and on a ridge northeast of Magnesium Canyon on th enortheast slope of the San Jacinto Mountains, in Sec. 22, T. 5 S., R. 5 E., S. B. M., 15 miles west of Indio and 11 miles southeast of Palm Spings; elevation 1600 ft. to 1850 ft. Owners are Mr. and Mrs. Milton L. Knapp, 346 East Amado St., Palm Springs, Calif.; under option to T. J. Young, Cathedral City, Calif.

The deposit was discovered in April, 1941, and three claims located along outcrops. The tactite occurs as a series of beds in granite; strike N. 45° W.; dip 15° to 20° to SW. Thickness of beds varies from 6 ft. to 13 ft. On Cottonwood No. 1 claim, at the head of Magnesium Canyon, a bed of tactite is exposed on both walls of the canyon. The bed of tactite is about 300 ft. in length and has a thickness of 3 ft. to 6 ft. Scheelite occurs associated with quartz, epidote and garnet; developed by several open cuts on north side of the canyon. Samples taken from these open cuts are reported to assay 1% to 1.5% WO_3. On Cottonwood No. 2 claim, which is located north of Cottonwood No. 1, and at 200 ft. in elevation above Magnesium Canyon, there is a bed of tactite exposed on the surface, the exposure being 100 ft. by 60 ft., by 13 ft. in thickness. It is estimated to contain 7000 tons.

Development consists of 4 trenches cut at 25-ft. intervals along the strike of lode to depths of 6 ft., then, 3 trenches run at right angles to lode with depths varying from 4 ft. to 18 ft. In the center of this system of trenches there is a shaft 25 ft. deep exposing 18 ft. of vein material. This shaft cut the foot-wall granite at a depth of 18 ft. A number of samples taken from the trenches and shafts are reported to assay 1% WO_3. The scheelite occurs associated with quartz, epidote and garnet.

On Cottonwood No. 3 claim, there are a number of remnants of tactite exposed on the surface reported to carry scheelite.

Water is available in the canyon for domestic and milling purposes. It is feasible to build a road to the deposit in Magnesium Canyon, a distance of approximately 1½ miles.

Miller Ranch Deposit comprises 160 acres situated in Martinez Canyon, in Santa Rosa Mountains, in Sec. 2, T. 8 S., R. 6 E., S. B. M., 24 miles southwest of Indio, California. Owner is J. C. Miller, P. O. Box 228, Hynes, California.

Ore occurs as tactite on granite-limestone contact. Development consists of 20-foot shaft and tunnel 56 feet; width of ore 2 feet to 7 feet; length 50 feet; surface outcrop.

Pawnee (Carr) Mine, comprising 4 claims, is in Sec. 31, T. 8 S., R. 3 E., S. B. M., on the south slope of Beauty Mountain, 6 miles northeast of Oak Grove and 9 miles from Aguanga; elevation 4000 ft. Owners are Emerson L. Carr and Wm. Carr, Aguanga, Calif.; leased to P. B. Mandel, 607 S. Park View, Los Angeles.

The deposit is of the contact metamorphic type, occurring at the contact of granite and limestone. Its strike is N. 40° E., dip vertical. The scheelite occurs in a garnetiferous gangue. The width of the ore varies up to about 8 ft. The shoot as opened on the surface, is some 70 ft. long.

Development work consists of 150-ft. vertical shaft with a tunnel level about 30 ft. below surface and other levels at 90 ft. and 140 ft. About 100 ft. of drifting has been done on each of these levels. On the surface a glory hole some 70 ft. long by 6 ft. to 8 ft. has been connected with the tunnel by raises. On the 60-ft. level, there is a stope about 30 ft. long by 6 ft. wide.

The present operator is remodeling mill to run the tailings from former operations. Mill consists of 10-in. by 20-in. jaw crusher, to 9-in. by 16-in. jaw crusher, elevator to bin, to another elevator to 20-mesh vibrating screen; oversize to impact crusher, elevator to screen, screenings to 2 jigs, to 2 small, homemade tables. Capacity about 100 tons per day.

Four men working on mill.

Bibl.: State Mineralogist's Rept. XXXVI, p. 48.

SAN BERNARDINO COUNTY

Blue Vase Tungsten Group of Mines comprises 5 claims situated in the Morongo Mining District, on the east slope of the San Bernardino Mountains, east of Rattlesnake Canyon, in Sec. 2, T. 2 N., R. 3 E., S. B. M., 25 miles northwest of Warrens Well and 45 miles northwest of Whitewater; elevation 7000 ft. Owner is William Baur, Los Angeles.

Scheelite occurs in narrow veins of quartz in schist along a sheer zone that strikes N.-S., dips 35° W. The width of the sheer zone is about 50 ft., and the formation, granite.

Development consists of two open cuts and 2 shallow shafts about 20 ft. deep. Two men employed on development work.

Brooke Molybdenite & Tungsten Mine comprises 4 patented claims, known as the Omega, Beta, Big Hunch and Big Hunch No. 1, situated in Sec. 35, T. 14 N., R. 15 E., S. B. M., on the south slope of the New York Mts., 7 miles south of Ivanpah. Crystals of hubnerite and wolframite occur, associated with molybdenite, irregularly disseminated throughout a pegmatite dike which dike varies in width from 25 ft. to 60 ft. Dike strikes N. 75° W. and dips S.

Development consists of a number of crosscut tunnels on vein dike and a shaft 150 ft. deep, with drifts on the 140-ft level. Ore extracted in this shaft is reported to assay .75% MoS_2 and .5% WO_3. Owners, J. F. Brooke and M. F. Brooke, of Barstow, California.

Dorr Tungsten Mine, comprising 3 claims, is in the New York Mountains, in Sec. 36, T. 14 N., R. 15 E., S. B. M., some 12 miles east of Cima; elevation 6800 ft. Owner is J. C. Dorr; leased to W. T. Potter, 2796 Boulder Road, Altadena, Calif.

The country rock on this property is granite. The deposit consists of quartz of magmatic segregation origin, through which is disseminated hübnerite.

Its strike is NW., with an apparent dip, as shown in the shaft of 55° SW. Its width is up to 80 ft. and it may be traced on the surface for several hundred feet. Quartz on the dump, reputedly from the 140-ft. level of the shaft, shows chalcopyrite which mineral was not observed on the surface nor on the 40-ft. level.

Development consists of a shaft sunk on the hanging-wall side on a streak of ore 3 ft. to 5 ft. wide, to a depth of 140 ft. This shaft was bulk-headed at the 40-ft level. On the 40-ft. level, there is a stope about 25 ft. each side of the shaft, 3 ft. to 5 ft. wide and 20 ft. high.

It is reported that the orebody was crosscut on the 140-ft. level 100 ft. to the northeast. At about 150 ft. below the shaft collar, an adit has been driven west 100 ft. This is caved at 70 ft. from the portal.

On the surface just south of the shaft, an open cut has been made in the deposit some 20 ft. long by 10 ft. wide. This ore was reportedly shipped to the mill where a recovery of one-half of 1% WO_3 was made.

An inclined, single-track tram about 650 ft. long lowers the ore from the mine to a 50-ton bin. From the bin, trucks haul the ore about 2 miles, southwesterly to the mill which consists of the following: 50-ton bin to 6-in. by 8-in. crusher; elevator to 50-ton bin, plate feeder to 5-ft. Huntington mill to Plat-o table; middlings to Economy table. Power is furnished by 50- h.p. oil engine. Capacity of mill about 40 tons. Operation is hampered by shortage of water.

Four men working.

Gillsmith & Victory Group of Claims situated 4 miles southeast of Ivanpah, in Sec. 17, T. 14 N., R. 15 E., S. B. M., on the northwest slope of the New York Mts.; elevation 4600 to 5000 ft. Holdings comprise 4 claims. Scheelite occurs in quartz veins, associated with fluorite. Veins vary in width from 12 in. to 3 ft. On a contact with granite and limestone. Ore reported to assay from one to two per cent WO_3. Development consists of shaft 10 ft. deep and a tunnel 65 ft. in length. Owner, H. S. Gillies, 3650 Revere Avenue, Los Angeles.

Paradise Mountains Tungsten Deposit comprises 10 claims situated in the south end of Paradise Mountains, 3 miles northeast of Olympus Mine, in Sec. 6 and 7, T. 12 N., R. 2 E., S. B. M., 25 miles northeast of Barstow. Owner is P. R. Hetherington, Los Angeles; elevation 3000 ft.

Scheelite occurs with quartz, garnet and epidote on contact of granite and dolomite. Development consists of a shaft 10 ft. deep and shallow open cuts. It is reported that there are 4 ft. of ore exposed in the shaft carrying from 1% to 2% WO_3. Idle.

Silver Star Group, comprising 5 claims, is in Sec. 6 and 7, T. 15 N., R. 14 E., about 12 miles north of Cima. Owners are Chas. H. Richards, 4218 W. 145th St., Lawndale, Calif., and C. E. Hammett, same address.

The country rock is granite and limestone with some narrow, diorite dikes. No scheelite has as yet been found at or near the contact. On a ridge which adjoins the mountain on the north and which is entirely composed of granite, with a few narrow, diorite dikes, a hole about 8 ft. deep has been dug on a vein, strike N. 20° W., dip vertical, with granitic walls. This vein which shows considerable copper stain is from 6 in. to 12 in. wide. There are two cross fractures which intersect this vein in the cut. The wedges formed by these intersections show some fine scheelite while the vein itself, in places, carries good values. One man is working in this open cut.

Standard Tungsten Mine, comprising the Standard and Bernice groups, a total of 8 claims, is in the Ivanpah Mountains, about 10 miles north of Cima and 10 miles southeast of Valley Wells. Owners are Riley Bembry, on the ground, and ——— Maynard and associates of Santa Ana, Calif.; under lease and bond to W. W. Hartman, 1230 E. 109th St., Los Angeles.

The deposits on this property occur at the contact of monzonite and crystalline limestone. The contact is marked by a body of tactite from 15 ft. to 40 ft. wide. Its strike is generally NE.-SW. The scheelite occurs where the tactite has been fractured, the gangue being largely garnet and epidote.

Development work on the Standard consists of a series of trenches across the tactite for a distance of some 600 ft. along its length. About 500 ft. southwest from the old Standard shaft, a larger trench has been made, some 60 ft. to the portal of a tunnel to be driven southwest. On the Bernice Group, about one mile to the southeast, trenching is also in progress. Some ore is being hauled in trucks to the operator's mill on the Valley View Mine, about 25 miles to the southeast.

The property is still in the prospect stage and no idea as to average values has yet been formed, although some high-grade ore has been encountered.

Star Dust Group of Tungsten Claims comprises 2 claims located in Sec. 12, T. 5 N., R. 1 W., S. B. M., 25 miles east of Victorville. Owner is Dr. W. W. Woods, 622 West Valley Blvd., Alhambra, California.

Sunnyside Mine (Livingstone & Morongo King) (gold-tungsten). It comprises 10 claims situated on the east slope of the San Bernardino Mountains, in the Morongo Mining District, in Sec. 27, T. 2 N., R. 3 E., S. B. M., 22 miles northwest of Warren's Well, and 44 miles northwest of Whitewater; elevation 5500 to 6000 ft. Owners are G. M. Bussey and E. F. Bain, Whitewater, Calif.

The property was located in 1887 as the Livingstone Gold Mine and operated by the Morongo King Mining Co., of San Bernardino, Calif. from 1887 to 1894. During this period there was a 10-stamp mill on the property.

In the latter part of 1941, the owner discovered scheelite, both in the gold quartz vein and along a bed of tactite parallel to the gold quartz vein. The Morongo King vein strikes NE.-SW. for a distance of 800 ft., then has a N.-S. strike. The vein dips 35° W.; width 6 ft. to 8 ft. The footwall is granite, with a narrow bed of limestone as hanging wall. The vein material is made up of a quartz vein 12 in. thick on hanging wall and quartz stringers in schistose material. The vein quartz is mineralized with free gold, associated with pyrite; also, with minor amounts of scheelite crystals.

Development consists of the Morongo King shaft sunk on the footwall of the vein on an inclination of 35° to a depth of 100 ft., with drifts on the 100-ft. level, 200 ft. southwest and 50 ft. northeast, with some stopes southwest of shaft. About 50 ft. west of the shaft, a tunnel has been driven 100 ft. southwest and east of the shaft, there is an open cut on the vein 20 ft. wide by 50 ft. in length and 20 ft. in height. There are 2 other shafts sunk on the vein to depths of 80 and 100 ft.

Northwest of gold vein, on the ridge above Morongo King shaft, are two roughly parallel beds of tactite in granite, being between a narrow bed of limestone and a massive belt of limestone. These tactite beds strike NE.-SW. and dip 35° NW. The beds of tactite have a thickness of 6 ft. to 10 ft. The tactite, where exposed by shallow cuts, is mineralized with scheelite. Samples taken from cuts are reported to carry from .7% to 2% WO_3. Further development on these beds of tactite should expose commercial ore. Two men are employed on development work.

Bibl.: State Mineralogist's Reports VIII, p. 504; IX, p. 227; XII, p. 231; XIII, p. 320; XV, p. 800.

SAN DIEGO COUNTY

Sundown Mine, comprising 2 claims, is on the summit of Laguna Mountain, Sec. 28, T. 15 S., R. 4 E., S. B. M., 6 miles west of Laguna Post Office and about one-quarter of a mile south of the Laguna-Julian road; elevation about 6250 ft. Owners are B. J. Chamberlain, Warner Hot Springs, Calif., and Eugene Rice, Winchester, Calif.

At the time of visit, the surface was covered with snow and the shaft filled with water, making it most difficult to get any information. Apparently the deposit strikes E.-W., dipping 65°-70° N. The gangue consists of garnet, quartz and calcite with iron and manganese oxide stains. Values are said to be in both scheelite and gold. The hanging wall is believed to be either limestone or schist, with a granitic footwall. This could not be verified at the time. The deposit appears to have a width of from 6 ft. to 10 ft. as indicated in a glory hole which was also filled with snow.

Development consists of 65-ft. shaft on about 70°, with levels reported at 20 ft. and 65 ft. On the 20-ft. level drift E. 30 ft., with 20-ft. crosscut north from face of drift. This level was connected by a raise to bottom of the glory hole which is about 30 ft. long, 6 ft. to 8 ft. wide by 8 ft. to 10 ft. deep. On 65-ft. level drift about 20 ft. west.

The shaft is equipped with 8-h.p. gas hoist. The mill on the property consists of 6 in. by 9 in. crusher, elevator to bin, automatic feeder to 3-ft. ball mill, peripheral discharge; one Economy table. Capacity about 10 tons per day. Plant was run by 30-h.p. gas engine which has been removed. Shut down for the winter.

SHASTA COUNTY

Washington Mine at French Gulch is operated by J. H. Scott Co. and Durand A. Hall of San Francisco. In the Dean vein, which is about 60 ft. north of the Washington vein, scheelite shows as small, light tan-colored crystals in calcite and quartz. The ore is principally white quartz with considerable pyrite and a little galena, sphalerite, and arsenopyrite.[3] The flotation mill of 35 tons capacity is treating the ore for its gold values; but the heavy jig concentrate and the tailings from the flotation cells both show scheelite under the ultraviolet lamp.

As yet no scheelite has been found in the Washington vein, but in the Dean vein it has been noted for a length of 30 ft. and from the 550-ft. to the 400-ft. level.

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[3] Averill, C. V., Mineral resources of Shasta County, State Mineralogist's Report XXXV, p. 157, Oct., 1939.

TULARE COUNTY

Gill Ranch Mine is on the ranch of that name in Sec. 12 and 13, T. 21 S., R. 29 E., M. D. M., Springville, Tulare Co. Owner is Vernon Gill; under lease to Carl D. McCutcheon and Lawrence E. Purnel.

The deposits, varying from 8 ft. to 10 ft. in width, occur at cross fractures along a contact of granodiorite and altered limestone. The strike of this contact is NW.-SE., dip vertical. The deposits have been prospected for 1000 ft. along the strike by open cuts and one 16-ft. shaft. The ore is said to carry 1% WO_3. The gangue is quartz-epidote-garnet, with a little calcite.

NEW MANGANESE AND CHROME ORE SPECIFICATIONS AND PRICES

The Metals' Reserve Company, Washington, D. C., the Government agency buying strategic minerals, under date of December 19, 1941, has released the following statement superseding schedule dated November 14, 1941. Particular attention is called to these changes made in the December 19th schedule:

1. Shipments are now accepted in single carload lots, instead of in minimum quantities of 250 tons.
2. Sampling is done at the stockpile location, with the consequent elimination of demurrage at the place of loading.
3. Cost of sampling, weighing, analysis and unloading onto the stockpile is now for the account of the Buyer, instead of the Seller.
4. Substantial increases have been made in price schedules of domestic chromite ores, and an intermediate grade has been established (classed as "Low Grade A").

INFORMATION CONCERNING PURCHASE OF DOMESTIC MANGANESE AND CHROME ORES

For the benefit and guidance of producers desiring to make offers of low grade manganese and chrome ores, Metals Reserve Company herein provides information describing in detail the specifications, price schedules, conditions of shipment and delivery, sampling and analysis which will be included in contracts for the purchase of manganese and chrome ores.

The present purchasing policy of the Metals Reserve Company is subject to change without notice, and the terms and provisions of each contract will be based on conditions and circumstances existing at the time of acceptance. The polices herein outlined do not apply to ores originating outside the limits of the continental United States.

MANGANESE ORES

1. QUANTITY: One thousand to ten thousand tons per contract. In cases involving large investment in plant and equipment for beneficiation of ore, contracts may be let for larger tonnages and on such terms as may be deemed appropriate in each case.
2. QUALITY: Purchases of domestic manganese ores will be of three grades with the following specifications:

	High Grade	*"Low Grade A"*	*"Low Grade B"*
Manganese—Minimum	48.0%	44.0%	40.0%
Alumina—Maximum	6.0%	10.0%	No Maximum
Iron—Maximum	7.0%	10.0%	No Maximum
Phosphorus—Maximum	0.18%	0.30%	0.50%
Silica—Maximum	10.0%	15.0%	No Maximum
Zinc—Maximum	1.0%	1.0%	1.0%

Size of Ore: None which will not pass a 6-inch screen, and not more than 12½% of fines which will pass a 20-mesh screen. Buyer may reject any shipment which does not conform to the applicable requirements and specifications as set forth above.

3. PRICE: Effective December 19, 1941, contracts will be considered on the following schedule for domestic ores, within the continental United States (excluding Alaska); all prices per long ton (2240 pounds) of dry weight, f.o.b. discharged onto stockpile designated by the Buyer.

   High Grade—Base price, $36 per long dry ton for ore containing 48.0% manganese with increase of seventy-five cents (75¢) per ton for each unit (22.4 pounds) in excess of 48.0%; fractions prorated.

   "Low Grade A"—Base price, $28.60 per long dry ton for ore containing 44.0% manganese; plus an increase of sixty-five cents (65¢) per ton for each unit (22.4 pounds) in excess of 44.0%; fractions prorated.

   "Low Grade B"—Base price, $22 per long dry ton for ore containing 40.0% manganese; plus an increase of fifty-five cents (55¢) per ton for each unit (22.4 pounds) in excess of 40.0%; fractions prorated.

   An allowance per long ton shipped equal to the freight tariff per long ton from the Seller's nearest convenient rail station to the Buyer's stockpile will be made, in addition to the above prices.

   The cost of sampling, analysis by the Buyer, weighing, and unloading onto the stockpile will be for the account of the Buyer.

   Under the contract, each lot will be priced under the grade the specifications of which it meets. Thus a lot carrying 45% manganese but also 0.50% phosphorus would be priced as "Low Grade B."

4. SHIPMENT AND DELIVERY: The Seller will give such advice regarding shipment and arrival as Buyer may require at least 10 days before the arrival of any shipment at stockpile; otherwise, any demurrage at the stockpile will be for Seller's account.

   Shipment will be made in flat bottom gondolas, if available, in lots of not less than one carload, to the stockpile designated by Buyer. The Seller will prepay the freight to such stockpile, where the ore will be weighed in cars, light and loaded, on track scales, and sampled for moisture. The lot will be sampled as unloaded and upon receipt of analysis, the Buyer will advise the Seller as to whether the ore is acceptable and under what classification.

   If the lot is ascertained to be unacceptable under the above specifications, the Seller will not be entitled to any allowance for prepaid freight and will be held responsible for the removal of this shipment from the stockpile location. Upon failure so to remove the shipment within fifteen days of due notice, the Buyer may, at his absolute discretion, remove such shipment and the cost of such removal shall be for Seller's account; or Buyer may, at his option, otherwise dispose of such shipment without any liability therefor.

In the event that Seller fails to repay Buyer for the cost of removal, within fifteen days thereafter, Buyer may cancel the contract forthwith.

5. PAYMENT: As soon as moisture and analysis determinations are received, the Buyer will promptly pay the Seller in accordance with the weight certificate and the above schedule.

6. WEIGHTS: The weight paid for will be net railroad track scale weights (weight of loaded car less weight of empty car), less moisture as determined by standard practice.

7. SAMPLING AND ANALYSIS: Each lot will be sampled at the time of unloading onto the stockpile by a sampler designated by the Buyer, three samples being taken, one each for Seller, Buyer and Umpire, and analysis made for manganese and other guaranteed elements. Usual provisions will be made for splitting limits and settlement by average of Seller's and Buyer's analyses, or by trade practice if samples are sent to Umpire. Moisture samples will be taken in accordance with standard practice. Seller may have representative at sampling at his own expense.

8. TERM OF CONTRACT: Deliveries must be completed within eighteen months of date of signing of contract. If delivery of 20 per cent of the tonnage contracted for has not been made within six months of date of signing the contract, the Buyer may cancel the contract forthwith.

CHROME ORES

The same general program and conditions will be followed on contracts for the purchase of chrome ores as outlined above for manganese ores, except as to quality and price.

1. QUALITY: Purchases of domestic chrome ores will be of three grades with the following specifications:

	High Grade	*"Low Grade A"*	*"Low Grade B"*
Chrome (Cr_2O_3)—Minimum	45.0%	40.0%	40.0%
Chrome (Cr)-Iron (Fe) Ratio—Minimum	2.5 to 1	2.0 to 1	No Minimum
Silica—Maximum	11.0%	13.0%	No Maximum
Phosphorus—Maximum	0.20%	0.50%	No Maximum
Sulphur—Maximum	0.50%	1.00%	No Maximum

2. PRICE: Effective December 19, 1941, contracts will be considered on the following schedule for domestic ores within the continental United States (excluding Alaska); all prices per long ton (2,240 pounds) of dry weight, f.o.b. stockpile designated by the Buyer.

   High Grade—Base price, $40.50 per long dry ton for ore containing 45.0% Cr_2O_3 and with a ratio of chrome (Cr) to iron (Fe) of 2.5 to 1; with an increase of ninety cents (90¢) per ton for each unit Cr_2O_3 in excess of 45.0% Cr_2O_3; with an increase of one dollar fifty cents ($1.50) per ton for each tenth increase in chrome-iron ratio to a maximum of 3.0 to 1. The chrome content of any ore is 68.4% of its chromic oxide (Cr_2O_3) content.

   "Low Grade A": Base price, $28 per long dry ton for ore containing 40.0% Cr_2O_3, and with a ratio of chrome (Cr) to iron (Fe) of

2.0 to 1; with an increase of ninety cents (90¢) per ton for each unit (Cr_2O_3) in excess of 40.0% Cr_2O_3; with an increase of one dollar fifty cents ($1.50) per ton for each tenth increase in chrome-iron ratio to a maximum of 3.0 to 1.

"Low Grade B": Base price, $24 per long dry ton for ore containing 40.0% Cr_2O_3, with an increase of sixty cents (60¢) per ton for each unit in excess of 40.0% Cr_2O_3. Requirements as to amount of fines are waived on this one class of material.

Fractions prorated in all cases.

An allowance per long ton shipped equal to the freight tariff per long ton from the Seller's nearest convenient rail station to the Buyer's stockpile will be made in addition to the above prices. The cost of sampling, analysis by the Buyer, weighing, and unloading onto the stockpile will be for the account of the Buyer. Under the contract each lot will be priced under the grade which specifications it meets. Thus a lot carrying 45.0% Cr_2O_3 and 0.50% phosphorus would be priced as "Low Grade A."

APPLICATIONS FOR CONTRACTS

Requests for information about contracts and offers of sale of manganese and chrome ores should be addressed to Metals Reserve Company, Washington, D. C., and should contain the following information:

1. Name of applicant, with business references, and statement of experience of applicant in connection with mining the above types of ores, other ores or nonmetallic products.
2. Description of the mining property from which it is expected to offer production, with data to show that ore is available, or can probably be made available in quantity to meet the contract requirements.
3. Statement of the tonnage offered for sale, rate of delivery, complete analysis of the ore to be delivered, and the location on railroad from which shipments will be made.

DOES SCHEELITE ALWAYS FLUORESCE?

By George L. Gary, Mineral Technologist

Stockpiles of tungsten metal and concentrates of its ores are being accumulated for the present National emergency and every effort is being made by producers to extract the highest possible percentage of the ores from the deposits.

Scheelite ($CaO\text{-}WO_3$) as a commercial ore of tungsten is of strategic inportance. The most convenient and rapid test for this mineral is to subject it to a source of ultra-violet light and note the resulting fluorescence. Sometimes this is the only test relied upon to determine the presence or absence of scheelite and in practically all instances it is conclusive.

Two cases have been noted, however, where specimens suspected of containing scheelite have been exposed to ultra-violet light without the appearance of fluorescence. The first case was a sample from Garnet Hill, Calaveras County, California, and the second case was a sample from near Unionville, Pershing County, Nevada. Upon being tested chemically the presence of scheelite was proved. The crushed ore fluoresced normally and a closer examination of the unbroken material revealed an oxide or silicate coating, on the surface which prevented fluorescence. This coating had the characteristics of iron oxide in one case but occurred in such thin coatings that ordinary wet tests could not be used to determine its composition. It is evident that the effects of such coatings can be avoided by exposing a fresh surface of the material.

We only wish to emphasize here that caution should be exercised in discarding specimens that do not show fluorescence especially on surface rocks that may be coated with some oxide or silicate.

BENTONITE

By George L. Gary, Mineral Technologist

Properties—Bentonite is composed principally of montmorillonite $(Mg,Ca)O.Al_2O_3.5SiO_2.nH_2O$, which is a massive clay-like, microcrystalline mineral of white, gray, greenish, or reddish color. It is exceedingly fine grained, very plastic, and highly absorbent. When moistened, it absorbs about three times its weight of water and expands ten or more times its original volume. Exposed surfaces are dull and powdery but a freshly cut surface usually has a waxy luster. It is easily fusible and is very soft. Specific gravity 2.5.

Occurrence—Most bentonite is formed by the alteration of volcanic ash, but some deposits are due to the devitrification of lavas and related rocks.

Bentonite outcrops are usually barren of vegetation and often present a crinkled coral-like appearance due to expansion after becoming wet. Immediately after a rain bentonite outcrops are frequently covered with a thick mass of slippery jelly, but in dry weather the surface may be dry and fluffy or may have a granular appearance.

In California, bentonite is found in Inyo, Kern, Los Angeles, San Luis Obispo, San Benito, San Bernardino, San Diego, and Ventura counties, and has been produced from all except Los Angeles County.

The deposits of montmorillonite on the mesas of both sides of the Otay River Valley, San Diego County, form a layer from two to six feet thick a few feet below the surface of the mesa, and underlie several hundred acres.

The extensive beds of bentonite along the Amargosa River in the vicinity of Tecopa, Shoshone, and Ash Meadows in Inyo County, are from one to 10 feet thick.

Bentonite in San Bernardino County occurs between Barstow and Daggett in masses of from 10 to 200 tons each.

Preparation—With the exception of the activable bentonites, the only treatment necessary is washing to remove impurities such as sand, gypsum, carbonaceous matter, etc. Much of the wash water is absorbed by the bentonite which necessitates a long and expensive drying period.

Activated bentonite (a substitute for fullers earth and other bleaching clays) is prepared by treating the clay with hydrochloric or sulfuric acid (usually sulfuric acid as it is cheaper). When the material loses its bleaching power it may be reactivated and used again.

Uses—The oil refining industry consumes the greater tonnage of bentonite which after activation is used as a bleaching agent. The raw or untreated material is used for filtering in oil refineries. It is also in demand for use in rotary well-drilling mud.

Bentonite is important during the present National emergency because of its use in foundry molding sands. It has bonding properties far greater than other clays, so that less clay is required in the sand, thus allowing more free space between the grains for the rapid escape of steam and gases created during pouring of the metal.

Other less important uses are in cement, for sealing earth dams, for filtering water, for cosmetics, and in horticultural sprays.

Experiments conducted in 1938 (See Minerals Yearbook 1939. Review of 1938, p. 1213) showed that bentonite may be used as a substitute for mica in a number of cases. The material is known as "alsifilm."

There are many other minor uses for bentonite and new ones are being discovered continually.

Tests—Bentonite may be recognized by its swelling action in water. It gives standard tests for aluminum, magnesium, and silica.

Markets—Per ton, carload lots f.o.b. Wyoming mines, dried and crushed, in bulk $8; in bags $10. F.o.b. Chicago, selected air-floated, $25. (Quotations as of December 18, 1941.)

Possible buyers—

Jerome Alexander, 50 East 41st St., New York, N. Y.
American Colloid Co., 365 West Superior St., Chicago, Ill.
American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y.
Baroid Sales Division-National Lead Co., 830 Ducommun St., Los Angeles, Calif.
Bartlett Chemicals, Inc., 923 Tchoupitoulas St., New Orleans, La.
Charles B. Chrystal Co., Inc., 18 Hudson St., New York, N. Y.
Coon Companies, Inc., 711 Gibbons St., Los Angeles, Calif.
Consolidated Minerals Co., P. O. Box 92, Long Island City, N. Y.
A. Daigger & Co., 159 West Kinzie St., Chicago, Ill.
Filtrol Corporation, 315 West Fifth St., Los Angeles, Calif.
Charles W. Garland Co., 412 West Sixth St., Los Angeles, Calif.
Hammill & Gillespie, Inc., 225 Broadway, New York, N. Y.
Innis, Speiden & Co., 117 Liberty St., New York, N. Y.
Kennedy Minerals Co., Inc., 2550 East Olympic Blvd., Los Angeles, Calif.
Los Angeles Chemical Co., 1960 Santa Fe Ave., Los Angeles, Calif.
Milwhite Company, Inc., P. O. Box 1283, Houston, Texas.
Owyhee Chemical Products Co., 435 North Michigan Ave., Chicago, Ill.
Pacific Coast Talc Co., 2149 Bay St., Los Angeles, Calif.
The Pontian Bentonite Co., Inc., 27 Pearl St., New York, N. Y.
Prior Chemical Corporation, 420 Lexington Ave., New York, N. Y.
L. A. Salomon & Bro., 216 Pearl St., New York, N. Y.
F. E. Schundler & Co., Inc., 620 Railroad St., Joliet, Ill.
Southern California Minerals Co., 320 South Mission Road, Los Angeles, Calif.
Albert E. Starkie, 528 No. Cuyler Ave., Oak Park, Ill.
Tamms Silica Co., 228 North La Salle St., Chicago, Ill.
United Clay Mines Corp., Prospect and Oakland Sts., Trenton, N. J.
Charles A. Wagner Co., Inc., 815 Callowhill St., Philadelphia, Pa.

Western Talc Co., 1901 East Slauson Ave., Los Angeles, Calif.
Whittaker, Clark & Daniels, Inc., 260 West Broadway, New York, N. Y.
Wishnick-Tumpeer, Inc., 295 Madison Ave., New York, N. Y.
The Wyodak Chemical Co., 4600 East 71st St. (Sta. D), Cleveland, Ohio.

References—

Bechtner, Paul. Bentonite. Industrial Minerals and Rocks. Seeley W. Mudd Series. A. I. M. E. 1937.

Devis, C. W., and Vacher, H. C. Bentonite: Its Properties, Mining, Preparation, and Utilization. U. S. Bureau of Mines Technical Paper 458. 1928.

Ladoo, Raymond B. Nonmetallic Minerals. Occurrence—Preparation—Utilization. McGraw-Hill Book Company, Inc., New York and London. 1925.

Minerals Yearbook, 1939. Review of 1938. U. S. Bureau of Mines, 1939.

Minerals Yearbook, Review of 1940. U. S. Bureau of Mines, 1941.

Pabst, Adolf. Minerals of California, Bulletin 113. California State Division of Mines. 1938.

Spence, Hugh S. Bentonite. Canada Department of Mines, Mines Branch. Report No. 626. 1924.

Tucker, W. Burling. Report of the State Mineralogist. Vol. 21 : 3. 1925 Page 360: vol. 22 : 3. 1926. Page 513.

NOTE.—Specimens of bentonite may be seen in the museum of the California State Division of Mines. Ferry Building, San Francisco, California.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

No changes in personnel are to be noted during the past three months.

New Publications

CALIFORNIA JOURNAL OF MINES AND GEOLOGY, April 1941, being chapter 2 of State Mineralogist's Report XXXVII. This chapter contains: "Geologic Progress of the California State Division of Mines, 1930-1940"; "California Earthquakes of the Mission Period, 1769-1938"; "Occurrence of Scheelite in Idaho-Maryland Mines at Grass Valley, California"; "Tungsten Resources of California." Also Special Articles on "Dragline Dredging in Siskiyou County"; "Marketing Talc, Pyrophyllite, and Ground Soapstone"; Abstracts on "Manganese" and "Magnesite."

COMMERCIAL MINERAL NOTES (Nos. 220, 221, 222) August, September, October, 1941, respectively. These 'Notes' contain the lists of 'mineral deposits wanted' and 'mineral deposits for sale', issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to five pages in recent months.

Mail and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum

Henry H. Symons, Statistician and Curator

STATISTICS

California Mineral Production for 1941

The total value of the mineral production of California for the year 1941, just closed, is conservatively estimated by the Statistical Section to be $367,784,000. This is partly detailed in the tabulation below, but as there are more than 60 mineral substances on California's commercial list, figures on the most important items only are available at this early date. The production report forms are being mailed to the operators in all mineral lines, and the detailed and completed report will be compiled and published later.

The estimated total of $367,784,000 is an increase of approximately $24,958,000 over the 1940 total value. The principal substances showing increases in value over the previous year were petroleum, cement, tungsten, quicksilver, miscellaneous stone, natural gas, lead, brick, and the industrial minerals group. Important minerals to register a decreased value were gold, copper, silver, and the saline group.

Petroleum output showed an increase of about 9,000,000 barrels in amount and about 6 percent in value over that of the previous year. The estimated quantity of crude oil was 230,157,000 barrels for 1941. There was an increase in the price paid to producers by the refineries starting in March. Natural gas showed an increase in both amount and value of that utilized compared with 1940.

Reports of the mint and smelters show the output of gold to be less than in 1940. The State's yield of tungsten, quicksilver, lead, zinc, chromite, manganese showed marked increases during the year, while copper, gold, and silver showed decreases. The output of quicksilver, tungsten, and silver each exceeded the million dollar mark as well as gold.

Of the structural group, cement, miscellaneous stone, brick, and magnesite all showed increases in amount and value over that of 1940. The cement production was the largest in the history of this industry in California; and for the first time all the plants approached capacity output. Under the miscellaneous industrial mineral group, stimulated business conditions and national defense increased the demand for many substances included in this classification so as to make it show a marked increase in total value. The saline group was the only group to show a decreased value for 1941; this was not brought about by lack of demand for minerals included under this classification but by one of the largest operators of these materials being shut down for three months by labor trouble.

The estimated values and quantities for 1941 are as follows:

$49,420,000	(1,412,000 fine ounces) Gold.
1,527,000	(2,147,000 fine ounces) Silver.
913,000	(7,810,000 pounds) Copper.
370,000	(6,610,000 pounds) Lead.
4,233,000	(23,500 flasks) Quicksilver.
3,450,000	(150,000 units) Tungsten Ore.
425,000	Other metals, including chromite, manganese ore, iron ore, platinum metals, antimony, titanium, zinc, etc.
220,260,000	(230,157,000 barrels) Petroleum.
21,055,000	(363,025,000 M. cu. ft.) Natural Gas.
27,531,000	(19,950,000 barrels) Cement.
14,000,000	Crushed rock, sand, and gravel.
3,200,000	Brick and hollow building tile.
2,100,000	Other structural materials, including bituminous rock, granite, lime, magnesite, marble, sandstone, slate.
7,100,000	Miscellaneous industrial materials.
12,200,000	Salines, including borates, potash, iodine, salt, soda, and others.
$367,784,000	Total value.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other states and foreign countries as well.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Besides its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the state and to San Francisco.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

Among the specimens received recently and catalogued for the Museum are the following:

21044 OPAL.
Locality: San Bernardino County, California.
Donor: J. K. Hodgson. In Case 225.

21045 GOLD-BEARING CALCITE.
Locality: Calhor Mine, Baguio, Benguet, Philippine Islands.
Donor: T. G. Muth. March, 1941. In Case 243.

21046 FIRE CLAY.
Locality: Ryan Ranch, Tesla, Alameda County, California.
Donor: Isbell Bros. March, 1941. In Case 403.

21047 SILVER ORES.
Locality: Calico District, San Bernardino County, California.
Donor: Mrs. J. R. Lane. March, 1941.

21048 COAL.
Locality: Hoopa Indian Reservation, Humboldt County, California.
Donor: Col. Morrison. March, 1941. In Case 208.

21049 DIOPTASE—H_2CuSio_4—(emerald green) associated with CERUSSITE crystals (white), some galena, and chrysocolla.
Locality: Mammoth Mine, Tiger, Pinal County, Arizona. 500-Ft. level.
Donor: St. Anthony Lead Co. March, 1941. In Case 130.

21050 NATIVE TELLURIUM, with considerable silica.
Locality: About ten miles southwest of Montezuma, Sonora, Mexico.
Donor: E. D. Morton. May, 1941. In Case 101.

21051 GOLD in QUARTZ (5 pieces).
Locality: San Mauricio Mine, Marsman & Co.,
Paracale District., P.I.
Donor: E. A. Nicolai. June, 1941.

21052 TEKTITE—of possible meteoritic origin.
Locality: Coco Grove placer operations, Marsman & Co.,
of Paracale Dist. P.I.
Donor: E. A. Nicolai. June, 1941. In Case 103.

21053 Dendritic GOLD on Quartz.
Locality: Potosi Mine, Salvador, Central America.
Donor: E. A. Nicolai. June, 1941.

21054 Ruby Silver PYRARGYRITE associated with Sphalerite, Tetrahedrite, Galena and Chalcopyrite in Quartz.
Locality: Property of Lava Cap Gold Mining Corp., Nevada City, Nevada County, California.—Banner 400 Level.
Donor: Lava Cap Gold Mining Corp. May, 1941. In Case 220.

21055 CASSITERITE, Sno_2 (in bottles) recovered by hydraulicking and dredging. Crystals from deposit on contact (decomposed) of granite and limestone.
Locality: Taknapa, Siam (Thailand).
Donor: S. Hancock. June, 1941.

21056 CINNABAR, (HgS). High grade nodules (2).
Locality: Dewey Quicksilver Lease, near The Geysers, Sonoma County, California.
Donor: Frank Dewey. June, 1941. In Case 234.

21057 CINNABAR, (HgS), crystals (two pieces).
Locality: Culver-Baer Quicksilver Mine, Sonoma County, California.
Donor: Henry S. Sweet. June, 1941. In Case 234.

21058 High grade SCHEELITE with Quartz, Epidote and Garnet.
Locality: Garnet Hill Mine, Calaveras County, California.
Donor: L. A. Smith. July, 1941. In Case 204.

21059 METACINNABAR, (HgS) Mercury sulphide.
Locality: Mount Diablo Quicksilver Mine, Contra Costa County, California.
Donor: Bradley Mining Co. August, 1941. In Case 309.

21060 SCHEELITE in quartz.
Locality: Inyo County, California.
Donor: J. H. Lester. August, 1941. Fluorescent Case.

21061 TOURMALINE—black—crystals with basal terminations, in Quartz and Clevelandite—a lamellar variety of Albite.
Locality: Pala Chief Mine, Pala, San Diego County, California.
Loaned by Walter W. Bradley. September, 1941. In Case 133.

21062 MAGNESITE and Limestone.
Locality: Santa Clara County, California.
Donor: Hugh Sherlock. September, 1941. In Case 230.

21063 GRAPHITIC Schist.
Locality: Campo Seco, Calaveras County, California.
Donor: Minnie L. Gallagher. September, 1941. In Case 405.

21064 JADE—nephrite.
Locality: Monterey County, California.
Donor: Francis J. Sperisen. September, 1941. In Case 617.

21065 CINNABAR (HgS).
Locality: Black Bear—Old Kentucky—on North Fork of Little Sulphur Creek, West of Culver-Baer Mine, Sonoma County, California.
Donor: Walter W. Bradley. September, 1941.

21066 CHRYSOTILE ASBESTOS.
Locality: Chas. Gillis Claims, 8 miles west of Altaville, Calaveras County, California.
Donor: Walter W. Bradley. September, 1941.

21067 SULPHUR CRYSTALS.
Locality: Sulphur Bank Mine, Lake County, California.
Donor: A. L. Rogers. September, 1941.

LABORATORY

By George L. Gary, Mineral Technologist

Since 1866 many lists have been published showing localities of California minerals. The last one, "Minerals of California," by Adolph Pabst, was published in 1938 by the Division of Mines as Bulletin No. 113.

It is the intention of the Division of Mines to publish in the quarterly new localities for minerals that are received by the laboratory for determination. So that this information may be accurate, it is requested that all specimens submitted for classification be accompanied by a letter giving the exact location where the material was found.

Corrections will also be noted as well as additions when called to our attention.

CORRECTIONS AND ADDITIONS TO BULLETIN 113

107. **Gersdorffite,** Ni As S, has been reported as occurring with *garnierite* (Ni, Mg) $SiO_3.nH_2O$ in the Pine Tree mine in Sec. 9, T. 4S., R 17 E., M. D. M. Mariposa County.

108. **Millerite,** a nickel sulfide and pentlandite a sulfide of iron and nickel occur with pyrrhotite (nickeliferous in part) and chalcopyrite in dike rock at the Ventura mine about 3 miles northeast of Triunfo, T.IN., R. 18 W., S. B. M.

109. **Torbernite,** a hydrous phosphate of uranium and copper, $Cu\ (UO_2)_2\ P_2O_8.\ 12H_2O$ should be added to the index of Bulletin No. 113 as it is noted on page 218 as occurring with autunite in the northeastern part of San Bernardino County.

110. High-grade **scheelite,** a calcium tungstate occurs with quartz, epidote and garnet at the Garnet Hill mine, just above the confluence of Moore Creek and the North Fork of the Mokelumne River, Calaveras County.

111. **Apatite,** a green calcium chloro- and fluo- phosphate has been reported from Mariposa County.

112. **Montmorillonite,** a calcium, magnesium, aluminum silicate has been reported from Bissell, Kern County.

113. **Valentinite** crystals, Sb_2O_3. were found lining several small vugs in a specimen of partly oxidized stibnite from Lone Tree Canyon, Kern County.

114. **Stolzite,** $PbWO_4$, lead tungstate crystals with a coating of tungstite, WO_3, tungsten trioxide, associated with cerussite, $PbCO_3$, lead carbonate, has been reported from the Darwin Lead-Silver Mine, Darwin, Inyo County.

LIBRARY

Henry G. Hubbard, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of Federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received which pertain particularly to mining in California.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED WHICH HAVE SPECIAL INTEREST OR REFERENCE TO CALIFORNIA

Governmental, National

U. S. Geological Survey
  Bulletins
    922-L Quicksilver Deposits of the Mayacmas and Sulphur Bank Districts, California.
    922-O Chromite Deposits of the Pilliken Area, El Dorado County, California.
    922-Q Tungsten Deposits in the Tungsten Hills, Inyo County, California.
    922-R Quicksilver Deposits in San Luis Obispo and Monterey counties, California.
    922-S Tungsten Deposits of the Benton Range, Mono County, California.
    925-D Geophysical Abstracts—October-December, 1940.
    927-A Superposition in the Interpretation of Two-Layer Earth Resistivity Curves.
    931-B Some Quicksilver Prospects in Adjacent Parts of California, Nevada and Oregon.
    932-A Geophysical Abstracts, January-March, 1941.
    914 (Correction Sheet) Microscopic Determination of the Ore Minerals.

Water Supply Papers
  868-A Investigations of Methods and Equipment used in Stream Gaging (Part 1).
  868-B Investigations (Part 2).
  879 U. S. Surface Water Supply (Part 9) Colorado River Basin.
Topographic Maps
  Devore Quadrangle, San Bernardino County.
  Firebaugh Quadrangle, Fresno and Madera counties.
  Ontario and Vicinity Quadrangle, San Bernardino County.
  Prado Quadrangle, San Bernardino, Riverside and Orange counties.
  Gausti and Vicinity Quadrangle, San Bernardino and Riverside counties.
  Swarthout Quadrangle, Los Angeles County.
  Waterman Mountain Quadrangle, Los Angeles County.
Professional Paper
  195 Geology of the Kettleman Hills Oil Field, California.
U. S. Bureau of Mines
  Bulletins
    431 Mechanical Concentration of Gases.
    437 Coal Mine Accidents in the U. S., 1938.
    438 Quarry Accidents in the United States, 1939.
    439 Some Essential Safety Factors in Tunneling.
    440 Metal and Nonmetal Mine Accidents in the U. S., 1939.
    42 Barricading as a Life-Saving Measure in Mine Fires and Explosions.
  Technical Papers
    632 Theoretical calculations for explosives.
  Report of Investigations
    No. 3564; 3567; 3569; 3570, 3571; 3574; 3576; 3578; 3580; 3582-3584; 3589.
  Information Circulars
    6884-R; 7164; 7169-7174; 7177; 7179; 7182-7183.
U. S. Geological Survey
  Bulletins, Water Supply Papers, Topographic Maps, Professional Papers.
U. S. Bureau of Mines
  Bulletins, Technical Papers, Report of Investigations, Information Circulars, Miners Circulars.

PUBLICATIONS RECEIVED CURRENTLY AND FORMER REPORTS AVAILABLE FOR REFERENCE

Governmental, State

Alabama Geological Survey, University.
Alaska (Territorial Commissioner of Mines), Juneau
Arizona Bureau of Mines, Tucson.
Arkansas Geological Survey, Little Rock.
Colorado Bureau of Mines, Denver.
Connecticut Geological and Natural History Survey, Hartford.
Florida Department of Conservation, Tallahassee.
Georgia Division of Geology, Atlanta.
Idaho Bureau of Mines and Geology, Moscow.
Illinois Geological Survey, Urbana.
Indiana Division of Geology, Indianapolis.
Iowa Geological Survey, Des Moines.
State Geological Survey of Kansas, Lawrence.
Kentucky Geological Survey, Frankfort.
Louisiana Department of Conservation, New Orleans.
Maine State Geologist, Augusta.
Maryland Geological Survey, Baltimore.
Michigan Geological Survey, Lansing.
Minnesota Geological Survey, Minneapolis.
Mississippi State Geological Survey, University.
Missouri Bureau of Geology & Mines, Rolla.
Montana Bureau of Mines and Geology, Butte.
Nebraska Geological Survey, Lincoln.
Nevada State Bureau of Mines, Reno.
New Jersey Department of Conservation and Development, Trenton.
New Mexico Bureau of Mines and Mineral Resources, Socorro.

New York Science Division, Albany.
North Carolina Geological & Economic Survey, Chapel Hill.
North Dakota Geological Survey, Grand Forks.
Ohio Geological Survey, Columbus.
Oklahoma Geological Survey, Norman.
Oregon State Department of Geology and Mineral Industries, Portland.
Pennsylvania Topographic and Geological Survey, Harrisburg.
South Dakota State Geological Survey, Vermillion.
Tennessee Division of Geology, Nashville.
Texas Bureau of Economic Geology, Austin.
Virginia Geological Survey, University.
Washington State Department of Conservation and Development, Pullman.
West Virginia Geological Survey, Morgantown.
Wisconsin Geological & Natural History Survey, Madison.
Wyoming Geological Survey, Cheyenne.

Governmental, Foreign

Alberta Research Council, Edmonton.
Argentina Direccion General de Minas y Geologica, Buenos Aires.
British Columbia Minister of Mines, Victoria.
British Museum and Natural History, London.
Canada Department of Mines, Ottawa.
Cuerpo de Ingenieros de Minas y Aguas del Peru, Lima.
Geological Service of Minas Geraes, Bella Horizonte, Brazil.
Geological Survey of Scotland.
Instituto Historica e Geographico Rio de Janeiro.
Museo de Historia Natural de Montevideo, Uruguay.
New South Wales Department of Mines, Sydney, Australia.
New Zealand Geological Survey Branch, Wellington.
Nova Scotia Department of Public Works and Mines, Halifax.
Ontario Department of Mines, Toronto, Canada.
Quebec Bureau of Mines, Quebec.
Queensland Department of Mines, Brisbane, Australia.
South Australia Department of Mines, Adelaide.
Transvaal Chamber of Mines, Johannesburg, South Africa.
Western Australia Geological Survey, Perth.

Societies and Educational Institutions

Academia de Ciencias y Artes de Barcelona, Spain.
Academy of Natural Sciences of Philadelphia.
American Association of Petroleum Geologists, Tulsa, Oklahoma.
American Geographical Society of New York.
American Institute of Mining and Metallurgical Engineers, New York.
American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia.
Australian Museum, Sydney.
California Academy of Sciences, San Francisco.
Canadian Institute of Mining and Metallurgy, Montreal.
Carnegie Institution of Washington.
Cleveland Museum of Natural History, Cleveland, Ohio.
Colorado College Publications, Colorado Springs.
Colorado Scientific Society, Denver.
Commonwealth Club, San Francisco.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago.
Franklin Institute of the State of Pennsylvania, Lancaster.
Geological Society of America, Columbia University, New York.
Geographical Society of London.
Institution of Mining and Metallurgy, London.
Instituto Geologico de Mexico, Mexico, D. F.
Journal of Geology, Chicago.
Mineralogical Society of America, Menasha, Wisconsin.
Michigan College of Mining and Technology, Houghton.
Mining and Metallurgical Society of America, New York.
Missouri School of Mines and Metallurgy, Rolla.

Museu Nacional, Rio de Janeiro.
National Research Council, Washington, D. C.
New York Academy of Sciences, New York.
New York State Museum, Albany.
Pennsylvania State College, State College.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide.
Seismological Society of America, Stanford University.
Sierra Club, San Francisco.
Society of Economical Paleontologists and Mineralogists, Fort Worth, Texas.
Southern California Academy of Sciences, Los Angeles.
Stanford University, Palo Alto, California.
University of California Publications in Engineering, Berkeley.
University of California Publications in Geography, Berkeley.
University of California Publications in Geology, Berkeley.
University of Harvard, Department of Mineralogy and Petrography, Cambridge, Mass.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Civil Engineering, New York City.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pennsylvania.
Mine and Mill World Digest, San Francisco.
Mining and Contracting Review, Salt Lake City.
Mineralogist, Portland, Oregon.
Mining Congress Journal, Washington, D. C.
Mining and Industrial News, San Francisco.
Mining and Geological Journal, Melbourne, Victoria, Australia.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining World, Seattle.
Nevada Mining Bulletin, Las Vegas, Nevada.
Nickel Steel Topics, New York City.
Northwest Mining, Spokane, Washington.
Northwest Science, Cheney, Washington.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pacific Purchaser, San Francisco.
Pacific Chemical and Metallurgical Industries, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.

Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers

The following papers are received and kept on file in the library:

Alaska Weekly, Seattle, Washington.
Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Courier Free Press, Redding, California.
Daily Commercial News, San Francisco, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Humboldt Beacon, Humboldt.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Los Angeles Times, Los Angeles, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mining Press, Reno, Nevada.
Mohave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
Needles Nugget, Needles, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Oil Marketer, Bayonne, New Jersey.
Owens Valley Press-Citizen, Lone Pine, California.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
Randsburg Times, Randsburg, California.
Shasta Courier, Redding, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.
Yreka Journal, Yreka, California.

New Books:

1. Fluorescent Light by Dake & DeMent (1941).
2. Minerals Year Book (Review of 1940) U. S. Bureau of Mines.
3. Crater Lake by Howell Williams (1941).
4. Report of Electro-thermic Reduction Process for Magnesium, by Todd-Calif. Shipbuilding Corporation (1941).
5. Petroleum World Annual Review (1941).

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past sixty-one years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available for reference, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Taft, Bakersfield, Coalinga. They may also be found in many public, private and technical libraries in California and other states and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained postpaid by addressing the San Francisco, Los Angeles or Sacramento offices and enclosing the requisite amount.

Remittances of stamps in an amount not to exceed 26 cents, currency or coin will be accepted at sender's risk. Payment is preferred in the form of money orders.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

Write for latest revised price list.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price (including postage and sales tax)
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----
Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks—Price $0.75, sales tax $0.02	$0.77
Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.—Price $0.75, sales tax $0.02	.77
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.—Price $1.50, sales tax $0.05	1.55
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----
Chapters of the State Mineralogist's Report, XIV Biennial Period, 1913-1914, Fletcher Hamilton:	
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper—Price $0.75, sales tax $0.02	.77
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913-1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----
Chapters of the State Mineralogist's Report, XV Biennial Period, 1915-1916, Fletcher Hamilton:	
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper—Price $0.75, sales tax $0.02	.77

REPORTS—Continued

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	Price (including postage and sales tax)
Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper Price $0.75, sales tax $0.02	$0.77
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper Price $0.75, sales tax $0.02	.77
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915-1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----
Chapters of the State Mineralogist's Report XVI, Biennial Period, 1917-1918, Fletcher Hamilton:	
Mines and Mineral Resources of Nevada County, 270 pp., paper Price $1.00, sales tax $0.03	1.03
Mines and Mineral Resources of Plumas County, 188 pp., paper Price $0.75, sales tax $0.02	.77
Mines and Mineral Resources of Sierra County, 144 pp., paper Price $0.75, sales tax $0.02	.77
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth Price $2.50, sales tax $0.08	2.58
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:	
**January, **February, **March, **April, May, June, July, August, September, October, November, December, 1922 Price $0.40, sales tax $0.01	.41
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923 Price $0.40, sales tax $0.01	.41
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, July, October, 1924, per copy Price $0.40, sales tax $0.01	.41
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties Price $0.40, sales tax $0.01	.41
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties Price $0.40, sales tax $0.01	.41
**July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	----
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties Price $0.40, sales tax $0.01	.41
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties Price $0.40, sales tax $0.01	.41
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----

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Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
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October, 1927, Mines and Mineral Resources of Mono County Price $0.40, sales tax $0.01	.41
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:	
January, 1928, Mines and Mineral Resources of Tuolumne County Price $0.40, sales tax $0.01	.41
April, 1928, Mines and Mineral Resources of Mariposa County Price $0.40, sales tax $0.01	.41
**July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	----
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Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
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October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties Price $0.40, sales tax $0.01	.41
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
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**April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	----
**July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	----
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Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	
January, 1931. Preliminary Report of Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete Price $0.40, sales tax $0.01	.41
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Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:	

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**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining ____________	----
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits, Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed) __________ Free, postage $0.05	.05
**July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist ____________	----
Chapters of Report XXIX, 1933 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic map showing various mines and prospects of part of Del Norte and Siskiyou Counties ____________ Price $1.00, sales tax $0.03	1.03
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Chapters of Report XXXI, 1935 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
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October. Mines and Mineral Resources of San Luis Obispo County. Mineral Resources of Portions of Monterey and Kings Counties. Mining Activity at Soledad Mountain and Middle Buttes—Mojave District, Kern County. Geology of a Portion of the Perris Block, Southern California. Mineral Resources of a Portion of the Perris Block, Riverside County — Price $0.60, sales tax $0.02	.62
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April. Geology, Mining and Processing of Diatomite at Lompoc, Santa Barbara County. Essentials in Developing and Financing a Prospect into a Mine. Gold-bearing Veins of Meadow Lake District, Nevada County. Semi-Precious Gem Stone Collection in Division Museum — Price $0.60, sales tax $0.02	.62
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Chapters of Report XXXIII, 1937 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Source Data of the Geologic Map of California, January, 1937. The Geology of Quicksilver Ore Deposits. Prospecting for Lode Gold — Price $0.60, sales tax $0.02	.62
April. Mineral Resources of Plumas County (with Geologic Map). List of preferred mineral names. New Placer Mining Debris Law — Price $0.60, sales tax $0.02	.62
July. Mineral Resources of Los Angeles County (with map showing principal Mines and Oil Fields.) Geology and mineral deposits of the Western San Gabriel Mountains, Los Angeles County — Price $0.60, sales tax $0.02	.62
October. Mineral Resources of the Resting Springs Region, Inyo County. Paleozoic Section in the Nopah and Resting Springs Mountains, Inyo County, California. Native Arsenic from Grass Valley, California — Price $0.60, sales tax $0.02	.62
Chapters of Report XXXIV, 1938 (quarterly): titled 'California Journal of Mines and Geology,' containing the following:	
January. Mineral Development and Mining Activity in Southern California during the year 1937. Doing Something About Earthquakes. Gold and Petroleum in California. Gem Minerals of California, Lapidary Art — Price $0.60, sales tax $0.02	.62
April. Gold dredging in Shasta, Siskiyou and Trinity Counties; Geology of the Central Santa Monica Mountains; Marketing Mica — Price $0.60, sales tax $0.02	.62
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Chapters of Report XXXVI, 1940 (quarterly) titled "California Journal of Mines and Geology," containing the following:	
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Chapters of Report XXXVII, 1941 (quarterly) titled "California Journal of Mines and Geology," containing the following:	
January, Mineral Resources of Trinity County; Strategic Minerals Procurement; Geologic Investigation of the Chromite Deposits of California; United States Supreme Court Renders Far-reaching Decision on Power Permits on "Navigable" Streams; Securities and Exchange Commission Price $0.60, sales tax $0.02	.62
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BULLETINS

**Bulletin No. 1. Description of Some Desiccated Human Remains, by Winslow Anderson. 1888, 41 pp., 6 illustrations	----
**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----
**Bulletin No. 4. Catalogue of California Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	----
**Bulletin No. 10. A Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----
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**Bulletin No. 14. Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means, 1899	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----
**Bulletin No. 17. Mineral Production of California, by Counties, for 1899, by Charles G. Yale. Tabulated sheet	----
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March 1, 1941.

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INDEX TO VOLUME XXXVII

Page
Abbott and McKay, Trinity County 83
Abraham Lincoln, George Washington and George Dewey Mine, Nevada County 451
Accidental Mine, Nevada County (see also Alcalde Mine) 444
Ackerman Mine, Trinity County 74
Acknowledgments 375
Adams, Turner, and Hart Mine, Trinity County 79
Adamson tungsten deposit, Inyo County 292
Administrative 190, 348, 486, 597
Agriculture in Trinity County 8
Ajax Mine, Nevada County 444
Alaska Mine, Nevada County 380, 444
    Mine, Trinity County 74
Alcalde Mine, Nevada County (see also Bowery, Seven Thirty or Kenosha) 381, 444
Alder Gulch Mine, Trinity County 74
Allen and Harmon Mine, Trinity County 79
    , John Eliot 90, 101
Allison Ranch Ford claim, Nevada County 382, 444
    Ranch Mine, Nevada County 381, 444
Alls Well Mine, Nevada County 444
Alpha Mine, Nevada County 444
Alpine claim, Nevada County 388, 444
    County, tungsten in 565
Alta and Bingham Consolidated Mine, Nevada County 444
    Bert Mine, Trinity County 74
    Hill Mine, Nevada County 444
    Mine, Nevada County 444
Altoona Mine, Trinity County 74
    Mine, Trinity County, photograph of 71
    Quicksilver Mining Co. 70
Alum minerals 350
Aluminum 475
Alvord Group, Inyo County 310
Amador claim, Nevada County 382
    Consolidated claims, Nevada County 382, 444
    County, tin occurrence in 550
Amanda claim, Nevada County 382, 444
American Tin Corp. 543, 551
    Gold and Tungsten Corp. 284
    Institute of Mining & Metallurgical Engineers, cited 344
Amy Balch Mine, Trinity County 24, 74
Ancho Mine, Nevada County 383, 444
Anderson, F. M., cited 21
Andy Fitz Mining & Milling Co. 383
    Mine, Trinity County 74
Angela claim, Del Norte County 119
Anita May claim, Tulare County 318
Annie and Russel Ravine Lodes, Nevada County 444
    McGrew Mine, Trinity County 74
Any Port in a Storm Mine, Nevada County 444
Apatite in Mariposa County 491, 602
Apex Mine, San Bernardino County 551
Apple Tree and Monte Christo Mine, Trinity County 83
Arctic Mine, Nevada County 384, 444
Argosy Mine, San Bernardino County 305
Arkansas Traveler Mine, Nevada County 444
Armstrong Mine, Trinity County 74
Arrow Point Chrome Mine, Trinity County 16, 74
Asbestos in Nevada County 378
    in Trinity County 16
Ash, S. H., cited 409
Atlantic Mine, Nevada County 444
Atolia deposits, San Bernardino County 264
    District, tungsten deposits in 283
    flotation plant 277
    Mining Co. 284
    Mining Co., photograph of leaching plant 252
    Mining Co., photograph of mill at 252
    Mining Co., photographs of shafts at property 256, 257
    Placer plant 276
    –Rand Placers, Inc. 285
Auroral Star Mine, Nevada County 444
Auto Mine, Trinity Co. 74
Autunite in San Bernardino County 491
Averill, Chas. V. 8, 201, 328, 499
    , Chas. V., cited 10, 11, 12, 36, 328, 587

Page
Baby Consolidated Mine, Nevada County 444
Badger Mine, Nevada County 444
Bagdad Chase Copper Co. 391
Bagley Mine, Nevada County 444
Bailey claim, Trinity County 25, 74
Bain, G. W., cited 347
  , H. F., cited 321
Baker prospect, Nevada County 444
Bald Mountain claims, Plumas County 135
  Point Mine, Trinity County 74
Baldwin Mine, Nevada County 444
Ball formation, Siskiyou County 129
Baltic Mine, Nevada County 444
Baltimore and Mayflower Mine, Nevada County 457
Banner Consolidated Mine, Nevada County 445
  Mine, Nevada County 421, 423
  Mountain Mine, Nevada County 445
Banon and Red Bank Mine, Trinity County 85
Barite in Humboldt County 504
  in Nevada County 378
  in Trinity County 16
Barron Mine, Nevada County 445
Barthol Jacobs Mine, Trinity County 74
Bartholf and Veach Mine, Nevada County 441
  Mine, Nevada County 445
Bartlett and Whipple Mine, Nevada County 467
Bateman, Alan M., cited 321
  and Mauldin Mine, Trinity County 74
Bates and Celina Mine, Nevada County 447
  and Van Matre Mine, Trinity County 74
Battle Peak Mine, Trinity County 74
Bavaria Mine, Nevada County 445
Bayard Taylor Mine, Nevada County 445
Bazet Mine, Trinity County (see also Beaudry) 25, 74
Baziuk Mine, Fresno County 565
Bear claim, Plumas County 135
  Tooth Mine, Trinity County 25, 74
Beaser Ranch Mine, Nevada County 445
Beasore Group, Madera County 313
Beaudry Mine, Trinity County (see Bazet)
Becker Mine, Nevada County 445
Beckman Mine, Nevada County 445
Bed Rock Tunnel Mine, Trinity County 74
Belcher Mine, Nevada County 445
Bell Gulch Mine, Trinity County 74
Bella Mine, Nevada County 445
Belle Fontaine Mine, Nevada County 445
Bellefountaine Mine, Nevada County (see also Ebaugh) 385
Belle Francis Mine, Nevada County 445
  of France claim, Nevada County 385, 445
  of France Mine, Nevada County 445
  Union Mine, Nevada County 445
Ben Franklin Consolidated Mine, Nevada County 445
  Franklin Mine, Nevada County 385
  Hur Divide Mining Co. 385
Bentonite 594
Bergin Placer Property, Humboldt County 508
  Hydraulic Mine, Trinity County 25, 74
  Hydraulic Mine, Trinity County, photograph of 26
Berkeley prospect, Nevada County 445
Berlin Consolidated Mine, Nevada County 445
Berriman Consolidated Mine, Nevada County 445
Berry and Thompson Mine, Nevada County 466
Betsy Mine, Nevada County 445
Bibliography, California chromite 165
  of magnesite 347
  of manganese 344
  of tin in California 553
  of tungsten 321
Big Bar Mine, Trinity County 20, 74
  Bend Mine, Nevada County 445
  Bend Mine, Trinity County 74
  Blue Mine and Butterfly Mine, Nevada County 446
  Blue Mine, Nevada County 445
  Chief Mine, Trinity County 74
  Creek Mine, Trinity County 74
  Dutchman Mine, Trinity County 74
  East Fork Mine, Trinity County 74
  Four Mine, Nevada County 445
  Grizzly Group, Mariposa County 580
  Stake Mine, Trinity County 74
Bigelow Mine, Trinity County 74
Biggs and Sims Mine, Nevada County 445
Bingham and Alta Consolidated Mine, Nevada County 444

Page
Bingo Claim, Trinity County ---- 54
Birchville Mine, Nevada County ---- 386, 445
Bishop District, Inyo County, tungsten in ---- 292
  Tungsten Co. ---- 292
Bismarck Mine, Trinity County ---- 74
Bitner Group, Nevada County ---- 445
Black Bear Mine, Nevada County (see also Forlorn Hope) ---- 386, 445
  Bess claim, Trinity County ---- 49
  Bess Extension claim, Trinity County ---- 49
  Cloud Group, Trinity County ---- 26, 74
  Crane claim, Trinity County ---- 17, 74
  Crow No. 1 and Black Crow No. 2 claims, Trinity County ---- 17
  Crow No. 1 and 2 claims, Trinity County ---- 17, 75
  Diamond claim, Glenn County ---- 133
  Eagle claim, Siskiyou County ---- 124
  Hawk Mine, Nevada County ---- 445
  Hawk Tungsten Mine, San Bernardino County ---- 286
  Jack Mine, Trinity County ---- 75
  Mountain and Blue Boy Group, Riverside County ---- 582
  Prince Mine, Nevada County ---- 445
  Rock tin deposit, Riverside County ---- 551
  Rock Tungsten Mine, Mono County ---- 314
  sand in Humboldt County ---- 504
Blackjack claim, Del Norte County ---- 119
Blagrave Mine, Trinity County ---- 75
Blake Mining Ground, Nevada County (see also Selby Hill) ---- 445
Bliss, Eleanora F., cited ---- 321
Bloss and McClary Mine, Trinity County ---- 75
Blue Bell Mine, Nevada County ---- 445
  Bird Consolidated Mine, Nevada County ---- 445
  Boy and Black Mountain Group, Riverside County ---- 582
  Cloud Consolidated Mine, Nevada County ---- 445
  Eagle claim, Siskiyou County ---- 124
  Fox Mine, Nevada County ---- 445
  Gravel Mine, Trinity County ---- 75
  Jacket Mine, Trinity County ---- 75
  Jay Group, Nevada County ---- 445
  Jay Mine, Nevada County ---- 446
  Jay Mine, Trinity County ---- 75
  Jib Mine, Trinity County ---- 75
  Lead Mine, Trinity County ---- 75
  Ledge Mine, Nevada County ---- 446
  Point deposit, Kern County ---- 312
  Rock Mine, Nevada County ---- 446
  Vase Group, San Bernardino County ---- 584
Bluejay Mine, Trinity County ---- 27, 75
Boalich, E. S., and Castello, W. O. cited ---- 285, 286, 287, 289, 290, 291, 295, 297, 298, 299, 306, 307, 310, 315, 316, 317, 321
Boarding House Mine, Trinity County ---- 75
Boeddecker, John Mine, Trinity County ---- 75
Bokay Bonanza Mine, Nevada County ---- 446
Bonanza King Mine, Trinity County ---- 75
  Mine, Trinity County ---- 75
Bondo Mine, Humboldt County (see Croton Bar & Markeson) ---- 508
Bonton Mine, Trinity County ---- 75
Boomer Mine, Trinity County ---- 75
Borates ---- 350
Boreham Mine, Nevada County ---- 446
Boss Consolidated Mine, Nevada County ---- 446
  Mine, Nevada County (see also San Juan) ---- 386
Boston Mine, Trinity County ---- 75
  Ravine Mine, Nevada County ---- 446
Boulder Consolidated Gold Mines Co. ---- 75
Boundary Mine, Nevada County (see also Grass Valley Boundary Mine) ---- 387, 446
Bourier Mine, Trinity County ---- 75
Bower and Matlock Mine, Trinity County ---- 75
Bowery Lode Mine, Nevada County ---- 446
Bowser Mine, Nevada County ---- 446
Boyd Mine, Trinity County ---- 75
Brackett Lode Mine, Nevada County ---- 387, 446
Bradley, Walter W. ---- 190, 348, 486
  Walter W., and R. P. McLaughlin, cited ---- 314, 324
  Walter W., cited ---- 14, 16, 70, 229, 232, 309, 310, 313, 318, 319, 321, 344, 347, 407, 572, 573, 574
Bradley's barite property, Nevada County ---- 446
Briceland Well, Humboldt County ---- 520
Brick and tile in Humboldt County ---- 505
Brickyard Lot Mine, Nevada County (see also Pratt and Dubuque) ---- 446
Brizzard Ranch Mine, Trinity County ---- 75
Brockington Consolidated Mine, Nevada County ---- 446
Bromine ---- 352
Brooke Molybdenite and Tungsten Mine, San Bernardino County ---- 584
Brooks Lode Mine, Trinity County ---- 75

Page
Brown and Rhodes deposit, Fresno County 309
  Bear Mine, Trinity County 27, 75
  Bear Mine, Trinity County, photograph of 27
  Dog claim, Trinity County 17, 75
  G. C., cited 286, 287, 290, 291, 321
  M. J., prospect, Trinity County 75
Brown's Bar Mine, Trinity County 75
  Mountain Mine, Trinity County 75
Brunswick Mine, Nevada County 446
  Mine, Nevada County, photograph of core sections 407
  Mine, Nevada County, photograph of headframe 406
Bryant, Harrison and Olcott Mine, Nevada County 453
Buck and Stock Placer Mine, Nevada County 434
  Mine, Trinity County 75
Buckeye Group, Nevada County 446
  Mine, Trinity County 47, 75
  Mining Co. 29, 75
  Tungsten Mine, San Bernardino County 286
Buckhorn Wedge and Gem Mine, Nevada County 446
Buena Vista claim, Nevada County 387, 446
Buffalo claim, Trinity County 54
Bulah and Sunnyside Mine, Nevada County 465
Bull Run Mine, Nevada County 446
Bullion Mine, Nevada County 380, 387, 446
Bully Choop Mine, Trinity County 29, 75
Bunker Hill Consolidated Mine, Nevada County 446
  Hill Mine, Nevada County 446
Burger Mine, Trinity County 75
Butterfly and Big Blue Mine, Nevada County 446
C. & H. Mining & Milling Co. 575
C. B. C. Mine, Nevada County 447
Cabin Flat Mine, Nevada County 446
Cacy Mine, Trinity County 75
Cadillac claim, Kern County 300
Cadmus Mine, Nevada County (see also Home) 446
Calaveras County, epidote in 491
  County, garnet in 491
  County, quartz in 491
  County, scheelite in 491, 602
Calcium chloride 353
Calcor Mine, Nevada County 446
Caledonia Mine, Nevada County 446
California and Calumet Mining Co. 447
  chromite in 101
  claim, Nevada County 388
  Consolidated Group, Nevada County (see also Gold Tunnel) 446
  Consolidated Mine, Nevada County 388
  Earthquakes of the Mission Period, 1769-1838 219
  Mine, Nevada County 447
  Mine, Nevada County (see also Great Eastern) 447
  Mine, Nevada County (see also Pittsburg and Pittsburg Extension) 446
  mineral production, 1941 598
  quicksilver program of the Federal Geological Survey 558
  tungsten deposits 282
Calmich Mine, Trinity County 76
Calumet and California Mining Co. 447
Camborne-Hayle Mine, Nevada County 447
Cambridge Mine, Nevada County 447
Camp 8, Del Norte County 122
  7, claim, Del Norte County 122
  7 Group, Del Norte County 121
Campbell and Howard Mine, Trinity County 80
  , J. M., cited 321
Camzo Mine, Trinity County 76
Canada Hill Consolidated Mine, Nevada County (see also Charonatte) 447
  Hill Mine, Nevada County 388
  Hill Mine, Trinity County 76
Canadian Group, Nevada County 447
Canton Mine, Nevada County 447
Canyon Creek Mine, Nevada County 447
  Placers, Inc. 29, 76
Cape Mendocino Oil Co. 526
Capitola Mine, San Bernardino County 286
Captain, San Luis Obispo County 143
Carbonate Group, San Bernardino County 306
Carlisle Mine, Nevada County 447
Carlson and Sandburg Mine, Trinity County 76
Carlyle Group, Nevada County 447
Carr, Joseph Mine, Trinity County 76
  Mine, Nevada County 447
  Mine, Trinity County 76
Carrie Mine, Trinity County 76
Carrville Gold Co. 30, 76
Carrville Gold Co., dredge, Trinity County, photograph of 31

Page
Carter Group, Nevada County 447
Cascaret Mine, Nevada County 447
Casey Mine, Trinity County (see Cacy Mine)
Cash in Dump Mine, Nevada County 447
Cassidy Consolidated Mine, Nevada County 447
Cassiterite in California 544
    in San Bernardino County 365
    index map showing recorded occurrences of 549
Castello, W. O., and Boalich, E. S., cited
    285, 286, 287, 289, 290, 291, 295, 297, 299, 306, 307, 310, 315, 316, 317, 321
Castle Crag Shasta County 131
Castro Extension, San Luis Obispo County 144
    No. 2, San Luis Obispo County 161
    , San Luis Obispo County 144
Caudwell Mine, Trinity County 76
Cecil and Clarence Pascoe Group, Kern County 313
Cedar Camp claim, Trinity County 17, 76
    Junction, claim, Trinity County 19
    Mine, Nevada County 447
Celia and Free Trade Mine, Nevada County 447
Celina and Bates Mine, Nevada County 447
Cement and Mule Creek Mine, Trinity County 76
Centennial Mine, Nevada County (see also Gold Point) 390, 447
Central and Gray Eagle Group, Nevada County 447
    and Jim Mine, Nevada County 447
    Consolidated Mine, Nevada County 447
    Mine, Nevada County 421, 422
    North Star Mine, Nevada County 447
    Pacific Mine, Nevada County 447
    Railroad Property, El Dorado County 138
    Shaft Mine, Nevada County 447
    South Yuba Mine, Nevada County 447
Chamberlain and Red Hill Mine, Trinity County 76
Chambers, G. H., cited 344
Champion Group, Nevada County 447
    Mine, Nevada County 447
    Mine, Trinity County 76
Champlain Mine, Trinity County 76
Chanchelulla Mine, Trinity County 76
Chandler, John W., cited 409
Chapman and Fisher Mine, Trinity County 76
    Mine, Trinity County 76
Charleston Mine, Nevada County 448
Charronnat claim, Nevada County 388, 448
Chase Mine, Nevada County 448
Chesapeake Mine, Nevada County 448
Chester Butler prospect, Nevada County 390
Chicago Mine, Nevada County 448
Chief of the Hills Group, Riverside County 551
Chiksan Oil Co. 76
Chillagite 239
Chilton mill, Humboldt County, Photograph of 509
    Mine, Humboldt County 509
China Bar Mine, Trinity County 76
Chipmunk deposit, Inyo County 293
Chloride claim, Trinity County 31, 76
Christopher Columbus Consolidated Mine, Nevada County 448
Chrome and manganese, new specifications and prices 589
    districts in California 116
    No. 2 claim, Trinity County 17, 76
Chromic Acid No. 1, San Luis Obispo County 141
    Acid No. 2, San Luis Obispo County 141
Chromite deposits, descriptions of orebodies 116
    deposits, genetic features 110
    deposits, geologic features 104
    deposits in Del Norte County 117
    deposits in El Dorado County 135
    deposits in Glenn County 133
    deposits in Klamath Mountains province 116
    deposits in Plumas County 135
    deposits in San Luis Obispo County 139
    deposits in Shasta County 131
    deposits in Sierra Nevada 134
    deposits in Siskiyou County 123
    deposits in southern California 139
    deposits in Tehama County 132
    deposits of California, geological investigation of the 101
    deposits, previous studies 104
    in California 101
    in Nevada County 379
    orebodies, characteristics 106
Chromium in Humboldt County 505
    in Trinity County 16
Chorro Creek claims, San Luis Obispo County 164

Page
Cincinnati Hill Mine, Nevada County 448
Cinco Mineros Co. 32, 76
Clarence and Cecil Pascoe Group, Kern County 313
Clay and Sneath Mine, Nevada County 464
  in Humboldt County 506
Clayton Mine, Trinity County 76
Clement Mine, Trinity County 76
Clemmer, J. Bruce and O'Meara, R. G., cited 321
Cleveland Mine, Nevada County 448
  Mine, Trinity County 76
Climate of Humboldt County 499
Cloudman, H. C., Merrill, F. J. H., and Huguenin, E., cited 285, 286, 287, 289, 290, 291, 306, 307, 308, 309, 316, 321
Clover Mine, Trinity County 76
Coal in Humboldt County 506
  in Trinity County 20
Coan Mine, Nevada County 448
Cobalt and Nickel, history of the names 472
Cobb, J. E., Property, Madera County 580
Codd Mine, Nevada County 448
Coe Mine, Nevada County 448
Coggins, Siskiyou County 129
Coghill, Will H., cited 344
Colby and McIlwaine Mine, Trinity County 76
Colling Mine, Nevada County 448
Colonel, San Luis Obispo County 143
Columbia Group, Nevada County 448
Comeback Consolidated Mine, El Dorado Co. 309
Comet Mine, Nevada County 448
Common treatments of complex ores 547
Compass Mine, Trinity County 76
Comstock Mine, Trinity County 76
Confidence Copper Mine, San Bernardino County 306
  Mine, Nevada County 448
Congo Mine, Nevada County 448
  and Oro Fino Mine, Nevada County 461
Conlon Mine, Nevada County 448
Connecticut Mine, Nevada County 448
Consolidated Mine, Nevada County (see Delhi) 448
  Mine, Trinity County 76
  Wyoming Mine, Nevada County 448
Consols Mine, Nevada County 448
Constitution Mine, Nevada County 448
Consumers and Producers 200, 371, 608
Contact, Iowa and Nob Hill Mine, Nevada County 454
Cook Spring, Humboldt County 520
Cooncan, Del Norte County 121
Copper claim, Nevada County 448
  in Humboldt County 507
  in Nevada County 379
  in Trinity County 23
Corinth Consolidated Mine, Nevada County 448
Coro Gold Mining Corp. 32
  Mine, Trinity County 76
Corona de Oro Mine, Trinity County 77
  Mine, Trinity County 77
Corporal, B. E. K., Texas Star No. 1 and No. 2 claims, Kern County 301
Corporations, Securities and Exchange Commission rules and regulations governing issuance of stock 184
Costa Mine, Trinity County 32, 77
Cotton King, Lent and January Mines, Nevada County 448
Coumbs, Wallace and Intram Mine, Trinity County 77
Cracker Jack Mine, Nevada County 448
Craig Mine, Trinity County 77
Crase, Albert, cited 405
Croesus Consolidated Mine, Nevada County 448
Crofton Mine, Trinity County 77
Crothers Property, Humboldt County (see Johnson Place) 509
Crow Creek Mine, Trinity County 77
Crown Point Mine, Nevada County (see also Wm. Penn Mine) 390, 448
Cuff and Foster Mine, Trinity County 78
Culbertson Mine, Nevada County 449
Cuproscheelite 240
Cuprotungstite 240
Curley Mine, Trinity County 77
Current notes 90
Curry and Gould Mine, Nevada County 452
Cyane Mine, Nevada County 449
Daisy Hill Mine, Nevada County 449
  King and Golden Shore Mine, Nevada County 449
  Mine, Trinity County 77
Dakota Mine, Nevada County 449
Dale, Don and Dee Mine, Nevada County 449
Dam End Mine, Nevada County 449

Page

Dana, Edward Salisbury, cited 321
  , J. D., cited 321
Dandarine Mine, Nevada County 449
Dannenbrink Mine, Trinity County 77
Darrington Property, El Dorado County 138
Darwin vicinity, tungsten deposits in 310
Davey Mine, Nevada County 449
Davis, H. W., and Ridgway, Robert H., cited 296, 324, 344
Dawn of Hope and Dutch Creek Group, Trinity County 33
  of Hope Mine, Trinity County 33, 77
Daybreak and Freedom Mine, Nevada County 449
Deadwood Mine, Nevada County 449
Dean, R. S., cited 321, 344
Debarnardi Mine, Nevada County 449
Dee, Don and Dale Mine, Nevada County 449
Deep Springs Valley deposit, Inyo County 310
Deer Creek Mine, Nevada County 449
  Lick Springs, Trinity County 69, 77
De Ferra, Siskiyou County 129
Defiance Group, Nevada County 449
  , Independence and Thompson Mines, Inyo County 567
  Mine, Nevada County 449
Delhi Mine, Nevada County 449
Del Norte County, chromite deposits in 117
Democrat barite Mine, Nevada County 378, 449
  Mine, Trinity County 77
DeVaney, Fred D., cited 344
Dewey Electrum and Pinnacle Mine, Nevada County 449
  George, Abraham Lincoln and George Washington Mine, Nevada County 451
Diamond Creek Mine, Nevada County 449
  Mine, Nevada County 449
  Mining and Development Co. 449
Dickerson Mine, Nevada County 449
Diller, J. S., cited 10, 11, 21
Dillon Mine, Nevada County 449
Dinero Mining Co. 449
Division Creek Tungsten Mine, Inyo County 568
Dixie Queen Mine, Trinity County 77
Dobbas Property, El Dorado County 139
Dock and Kise Mine, Trinity County 77
Dodge Ranch Mine, Trinity County 77
Dodo Mine, Nevada County 449
Doe Creek, Siskiyou County 123
Doerner, H. A., cited 321
Dolly Varden Mine, Trinity County 77
Don, Dale and Dee Mine, Nevada County 449
Doolittle Mine, Nevada County 449
Dorleska Mine, Trinity County 33, 77
Dorr, John V. N., 2d, and Dwight M. Lemmon, cited 253, 254, 257, 287, 324
  Mine, San Bernardino County 584
Dorsey and Ridge Mine, Nevada County 449
Douglas City Mine, Trinity County 77
Dragline Dredging in Siskiyou County 328
Drake Mine, Trinity County 77
Drinkwater Mine, Trinity County 77
Driver Mine, Trinity County 77
Dromedary Mine, Nevada County 449
Dry Mine, Trinity County 77
Dublin Bay Consolidated Mine, Nevada County 449
Dubuque and Pratt Mine, Nevada County 462
Duggan manganese prospect, Nevada County 441
Dull Mine, Nevada County 449
Dulmaine Mine, Nevada County 449
Duschak, L. H., O. C. Ralston, and R. D. Pike, cited 347
Dutrete Group, Nevada County 449
Eagan's Flat Mine, Trinity County 77
Eagle Bird claim, Trinity County 54
  Bird Consolidated Mine, Nevada County 450
  Bird mine, Nevada County 391
  Mine, Nevada County 450
  , San Luis Obispo County 141
Eakle, A. S., cited 313, 314, 315, 322, 552
Earthquakes of the Mission Period 219
East Eureka Mine, Nevada County 450
  Fork Mine, Trinity County 77
  Home Mine, Nevada County 450
  Star Mine, Nevada County 450
Eastern San Bernardino County District, tungsten in 305
Eastman Consolidated Mine, Trinity County 77
  Mine, Trinity County 77
Eckel, Edwin B. 558
Eclipse Mine, Nevada County 450
Economics of tungsten 230
Edison Mine, Nevada County 450

Page
Eddy, L. H., Wm. Forstner, T. C. Hopkins and C. Naramore, cited 316, 322
Edman, J. A., A. Hausmann, J. Kruttschnitt, Jr., and W. E. Thorn, cited 308, 322
Effie Bell and Lucky Strike Mine, Trinity County 82
Egenhoff, Elisabeth L., cited 553
Ehrman Mine, Trinity County 77
Elder Creek, Tehama County 132
El Diablo Mining Co. 294
El Dorado Co., chromite deposits in 135
  Co., tungsten in 309
  Mine, Trinity County 77
Electric Mine, Nevada County 450
Elevator Mine, Trinity County 77
Elliston Mine, Trinity County 77
El Oro Mining Co. 434
Emergency Group, Inyo County 311
Emily Mine, Nevada County 450
Emmet Mine, Nevada County 450
Empire and North Star Mines, Nevada County 315
  Claim, Trinity County 18, 77
  Mine, Nevada County 443, 450
  Mine, Nevada County, photograph of headframe and surface plant 392
  Star Mines Co. 380
  Star Mines Co. Ltd. 392
  West Mine, Nevada County 450
Employment Service 200, 372, 608
Empress Mine, Nevada County (see also Dull or Newtown) 397, 450
Engineering and Mining Journal, cited 322
English Mountain Mine, Nevada County 450
  Tom Mine, Trinity County 77
Enterprise Mine, Nevada County 450
  Mine, Trinity County 33, 77
Epidote in Calaveras County 491
  –garnet–scheelite ore, photograph of 248, 249
Erie claims, Nevada County 383
  Consolidated Mine, Nevada County 450
Erwin, H. D., cited 314, 322
Estabrook Dredge, Trinity County, photograph of 31
  Gold Dredging Co. 77
Estrella, San Luis Obispo County 161
Ethel and South Mine, Nevada County 450
  Mine, Nevada County 397
Eucalyptus No. 1, San Luis Obispo County 141
  No. 2, San Luis Obispo County 142
Eureka Consolidated Mine, Nevada County (see also Roannaise) 450
  Mine, Trinity County 78
  , San Luis Obispo County 140
Evans Bar Mine, Trinity County 78
Evening Star and North Star claims, Trinity County 53
Excelsior Mine, Trinity County 78, 450
Extension Blue Jay Mine, Trinity County 78
Fahey Mine, Nevada County 450
Fair Play Mine, Nevada County 450
Fairbanks, H. W., cited 550
Fairview claim, Del Norte County 118
  Mine, Nevada County 451
  Mine, Trinity County 34, 78
Farmin, Rollin 224
Federal Company's Group, San Bernardino County 286
  Geological Survey, California Quicksilver, program of 558
  Loan Mine, Nevada County 385, 451
  Mine, Trinity County 78
Feldman Tungsten Mine, Inyo County 311
Felts Spring, Humboldt County 520
Ferberite 237
Ferguson, H. G., cited 28
Fernando Mine, Fresno County 571
Ferritungstite 239
Field, Shafer and Schloerb Group, San Bernardino County 308
Fields-Meckel Mine, Trinity County 48, 78
Fillmore Mine, Nevada County 451
Finch, John W., cited 97
Fink, C. G., cited 290, 291, 295, 297, 299, 307, 308, 316, 322
  , Colin G., and Jones, F. L., cited 322
Fisher and Chapman Mine, Trinity County 76
  Gulch Mine, Trinity County 78
Fitterer, G. R., and M. B. Royer, cited 344
Five Pines Mine, Trinity County 78
Floe, C. F., cited 347
Florence Mine, Trinity County 78
Flotation of tungsten minerals 274
Foggarty and King Mine, Trinity County 78
Foote, Arthur B., cited 437
Forest Mine, Nevada County 451
Forget-Me-Not Mine, Trinity County 78
Forlorn Hope Mine, Nevada County 451

Page
Forstner, Wm., T. C. Hopkins, C. Naramore and L. H. Eddy, cited 316, 322
Fort Baker Mine, Humboldt County (see Porter Ranch) 518
  Seward Mine, Humboldt County 519
Fortuna Mine, Nevada County 451
Foss and Skaggs Group, Trinity County 68
Foster and Cuff Mine, Trinity County 78
  Mine, Trinity County 78
Fouch and Malony Mine, Nevada County 457
Fountain Head Mine, Nevada County (see Eureka Placer) 451
  Head Mine, Trinity County 78
Four Brothers Mine, San Bernardino County 316
  K. Tungsten Mine, Kern County 575
  Point Mine, Trinity County 78
Fourth of July Mine, Nevada County 451
Fowler Mine, Trinity County 78
Fraction Mine, Nevada County 451
Franke, H. A., cited 318, 322
  , Herbert A., and M. E. Trought, cited 347
Frankford Mine, Nevada County 451
Franklin Mine, Nevada County (see also Ford) 451
Frederick Mine, Nevada County 451
Free Trade and Celia Mine, Nevada County 447
Freedom and Daybreak Mine, Nevada County 449
Freeman Group, Nevada County 451
Freethy Mine, Trinity County 78
French Bar Mine, Trinity County 34, 78
  Bar Mining Co. 34
Fresno County, tungsten in 309, 565
  County, tungsten occurrences in 586
Friendly Peace Mine, Nevada County 451
Gambler Gold and Silver Mine, Nevada County 451
Gambrinus Mine, Nevada County 451
Garage Mine, Nevada County 451
Garden Gulch Mine, Trinity County (see also Woodbury) 78, 89
Garnet Dike Mine, Fresno County 566
  in Calaveras County 491
  -epidote-scheelite ore, photograph of 248, 249
  in Nevada County 380
  Queen Mine, Riverside County 582
Garnierite, in Mariposa County 491
Gary, Geo. L. 194, 342, 345, 365, 475, 478, 491, 594, 602
  , Geo. L., cited 593
Gasquet Group, Del Norte County 118
Gaston Mine, Nevada County (see also Gambrinus and California) 399
  Ridge Consolidated Mine, Nevada County 451
Gautier Ranch Mine, Nevada County 451
Geach Property, Nevada County 451
Gem, Buckhorn, and Wedge Mine, Nevada County 446
  Mine, Trinity County 78
General Dredging Co. 434
  Grant Mine, Nevada County 451
  Lee claim, Trinity County 48
  MacArthur Group, Kern County 575
  Miles Mine, Nevada County 451
Geneva Trinity Mine, Trinity County 35, 78
  -Trinity Mining Co. 35
Geography of Humboldt County 499
  of Trinity County 8
Geologic Branch 90, 202, 469, 529
Geological Investigation of the Chromite Deposits of California 101
  Progress of the California State Division of Mines, 1930 to 1940 205
Geology of California, and the Occurrence of Oil and Gas 469
  of Humboldt County 501
  of tin 545
  of Trinity County 10
  of tungsten ores 240
George, R. D., cited 322
  Washington, Abraham Lincoln and George Dewey Mine, Nevada County 451
German Bar Consolidated Mine, Nevada County 451
  Mine, Nevada County 451
Gersdorffite in Mariposa County 491, 602
Gianella, Vincent P., cited 322, 565
Giant King Mine, Nevada County 399, 451
Gibson and Smith Creek Mine, Trinity County 86
Gifford Mine, Trinity County 78
Gill Ranch Mine, Tulare County 588
Gillsmith and Victory Group, San Bernardino County 585
Gilzean Mine, Trinity County 78
Gladstone Mine, Nevada County 451
Glencoe Mine, Nevada County 451
Glenn County, chromite deposits in 133
  Mine, Nevada County 451

Page

- Globe Consolidated Mine, Trinity County (see also Bailey and Chloride) 35
  - Mine, Nevada County (see also Round Mountain Champion) 400
  - Mine, Trinity County 78
- Goat Camp Group, Trinity County 67, 78
- Gold Bank Tunnel Co. 451
  - Bar Dredge Property, Trinity County 78, 82
  - Bar Mine, Nevada County 451
  - Bar and O.K. Mine, Nevada County 460
  - Blossom Mine, Nevada County 451
  - Cord Development Co. 515
  - Crown Consolidated, San Bernardino County 287
  - Dollar Mine, Trinity County 78
  - Flat Mine, Nevada County (see also Mohigan) 452
  - Hill claim, Trinity County 49
  - Hill Mine, Nevada County 452
  - Hill No. 1 claim, Trinity County 49
  - in Humboldt County 508
  - in Trinity County 24
  - , its use as a medium of exchange 436
  - King claim, Trinity County 36
  - King Mine, Nevada County 452
  - Leaf Mine, Trinity County 79
  - Mound Mine, Nevada County (see also Boyle and Roach Placer) 452
  - Point Mine, Nevada County 452
  - quartz mining in Nevada County 380
  - Queen claim, Trinity County 36
  - Ridge Mine, Trinity County 79
  - Run Consolidated Mine, Nevada County 452
  - Run Mine, Nevada County 452
  - Standard Group, San Diego County 317
  - , the common unit of foreign trade 438
  - , the price of 437
  - Tunnel Mine, Nevada County 388, 452
  - Wedge Mine, Nevada County 452
- Golden Age and Mount Hope Mine, Nevada County 458
  - Bow Mine, Trinity County 78
  - Center Group, Nevada County 452
  - Center Mine, Nevada County 400
  - Chain Mine, Nevada County 452
  - Chest Mine, Trinity County 78
  - Eagle Mine, Nevada County 452
  - Eagle Mine, Trinity County 79
  - Gate Group, Nevada County (see also Kentucky and Alpha) 401, 452
  - Gate Mine, Nevada County 452
  - Gravels Mine, Trinity County 35, 79
  - Gravels Mining Co. 35
  - Jubilee Mine, Trinity County 36, 79
  - King Group, Trinity County (see also Jumbo) 36, 79
  - Lilly Group, Nevada County (see also Golden Lead, Silver Pick, Buckskin and Red Rock) 452
  - Shore and Daisy King Mine, Nevada County 449
  - Star Lode, Nevada County 452
  - Star Mine, Trinity County 79
- Goldfield Consolidated Mines, Trinity County (see also Jacobs, Red Hill) 37, 79
  - Consolidated Mines Co. 37
  - Consolidated Mines Co., Property, Trinity County, photograph of 37
- Good Enough No. 1 and No. 2 claims, Nevada County 441
  - Friday and Red Sunday Mine, Trinity County 79
  - Hope and Little Dick Group, Kern County 301
  - Hope Mine, Kern County 250, 251
  - Hope Mine, Kern County, photograph of mill at 258
  - Hope Mine, Nevada County 452
- Goodall Consolidated Mine, Nevada County 452
- Goodyear Mine, Nevada County 452
  - , W. A., cited 550
- Gould and Curry Mine, Nevada County 452
  - Mound Mine, Nevada County 452
- Gracie Mine, Nevada County 452
- Graf Group, Trinity County 79
- Grafton Mine, Nevada County 452
- Graig Mine, Trinity County 79
- Grand National Mine, Trinity County 38, 79
  - National Mining Co. 38
- Granite Hill Mine, Nevada County 452
  - in Trinity County 67
- Grant and Canada Hill Mining Co. 452
  - claim, Nevada County 389, 452
- Grass Valley and Nevada City District, Nevada County, map of in back cover of
  - Valley-Boreham Gold Mining County 452
  - Valley Creek Mine, Trinity County 79
  - Valley Extension Mine, Nevada County 402
  - Valley Gold Mines, Nevada County 452
  - Valley Rock and Sand Co. 443
- Graton and Hess, cited 550, 552
- Graves Mine, Trinity County 79

Page
Gray Eagle and Central Group, Nevada County 447
  Eagle Mine, Nevada County 452
Great Bear, Grey Eagle and Springer Mine, Nevada County 452
  Britain Mine, Nevada County 453
  Eastern and Great Western Group, Nevada County 453
  Eastern Group, Nevada County (see California) 453
  Northern Gold Mines, Inc. 402
  Northern Mine, Nevada County 453
Greely Blackman Mine, Nevada County 453
Green Emigrant Mine, Nevada County 453
  Mine, Nevada County 453
  Monster Mine, Kern County 313
  Mountain Mine, Nevada County 453
  Stripe Chrome Mine, No. 1 and No. 2 claims, Trinity County 18, 79
  , Volente and Maltos Mine, Trinity County 83
Greenhorn Creek Mine, Nevada County 453
  Mine, Nevada County 453
Greenman claim, Nevada County 389, 453
Greenockite in San Bernardino County 194
Grey Eagle, Glenn County 134
  Eagle, Great Bear and Springer Mine, Nevada County 452
  Eagle Mine, Nevada County 453
Greystone Group, Nevada County 453
Gribble Mine, Trinity County 79
Grizzly Ridge claim, Nevada County 453
  Tungsten No. 1 Mine, Plumas County 581
Grover and Hirschman Mine, Nevada County 453
  Cleveland Mine, Nevada County 453
  , N. C., cited 8
Grub Stake Mine, Nevada County 453
Guadalupe Tungsten Mine, San Bernardino County 316
Gunther Group, Trinity County 38, 79
  Group, Trinity County, photograph of dredge 39
Gurit, Adolph, cited 322
Gurney Property, El Dorado County 138
Gustave Group, San Bernardino County 287
Gwynne and Jennette Mines, Kern County 575
Gypsie Queen Mine, Trinity County (see also Gold Standard) 39, 79
Haas and Hager Mine, Trinity County 79
Hackett Property, Humboldt County 516
Hadfield, Robert A., cited 322
Hager and Haas Mine, Trinity County 79
Haiselton Mine, Nevada County 453
Hamburg, Siskiyou County 125
Hammer Mine, Trinity County (see also Swanson Mining Corp.) 56, 79, 87
Hang Bar Mine, Trinity County 79
Hanks, H. G., cited 550, 552
Hansen, E. E. Mine, Trinity County 79
Haphine Mine, Nevada County 453
Happy Home Mine, Trinity County 79
Harden, D. B., cited 429
Hardscrabble Mine, Trinity County 79
Hardtack Mine, Trinity County 79
Hard Times Mine, Trinity County 79
Harmon and Allen Mine, Trinity County 79
Harold Mine, Trinity County 79
Harris, Shorty, Tungsten Mine, Inyo County 573
Harrison, Bryant and Olcott Mine, Nevada County 453
Hart, Turner and Adams Mine, Trinity County 79
Hartery Consolidated Mine, Nevada County 453
Hartman, M. L., and Runner, J. J., cited 325
Harveston Bar Mine, Humboldt County 510
Haskins Mine, Trinity County 79
Hathaway Ledge Mine, Nevada County 453
Haunted Bar Mine, Trinity County 79
Hausmann, A., Kruttschnitt, J., Jr., Thorn, W. E., and Edman, J. A., cited 308, 322
Hawkins Bar Mine, Trinity County (see also Brizzard Ranch) 79
  Del Norte County 120
Hay Press placer claim, Trinity County 48, 53
Hayes, Siskiyou County 128
Hayfork Creek Mine, Trinity County 79
  Dredge, Trinity County 39, 80
  Gold Dredging Co. 39
  Mine, Trinity County 79
  Valley Mine, Trinity County 79
Hayward Hydraulic Mines, Trinity County 40, 80
  Mine, Inyo County 571
Hazel Mine, Trinity County 80
Headlight Mine, Trinity County 80
Headstrom Mine, Trinity County 80
Heimburger and Prussian Mine, Trinity County 85
Heizer, O. F., cited 261, 323
  , Robert F. 219
Helen D Mine, Nevada County 453
Hemstreet and Bell quarry, Humboldt County 527

Page
Henderson Mine, Trinity County 80
Heninger Mine, Trinity County 40, 80
Henrietta Mine, Nevada County 453
Henry Clay claim, Trinity County 40, 80
Hermosa Mine, Nevada County 453
Herschel Kelso claim, Kern County 302
Hershey, O. H., cited 10
Hess and Graton, cited 550, 552
  , F. L., cited 288, 295, 296, 297, 299, 314, 316, 323, 347
  , Frank L., and Larsen, E. S., cited 295, 296, 299, 301, 302, 303, 305, 310, 315, 317, 318, 323
  , Frank L., and Schaller, W. T., cited 323
Heuston Hill Mine, Nevada County 453
Hickson Mine, Nevada County 453
Hidden Treasure Mine, Nevada County 453
  Treasure Mine, Trinity County 80
High Grade Group, Nevada County 453
  Plateau Group, Del Norte County 117
Highland Lake Mine, Trinity County 80
  Mine, Trinity County 80
Hilda and Ragon Mine, Nevada County 453
Hill Crest Mine, Trinity County 80
  Lode Mine, Nevada County 453
Hilliard Mine, Trinity County (see also Daisy) 80
Hilltop, San Luis Obispo County 162
Hindley Mine, Trinity County 80
Hinds, N. E. A., cited 10, 12
Hirschman and Grover Mine, Nevada County 453
History of California tin 533
  of California tungsten 229
  of Humboldt County 499
  of the names cobalt and nickel 472
Hobbs, W. H., cited 323
Hocker Mine, Trinity County 80
Hocking Ranch, Nevada County 453
Hodges Mine, Trinity County 80
Hodgson, J. claim, Kern County 313
Hoeft lease, Nevada County 453
Hoelling claims, Trinity County 18, 80
Hoge Mine, Nevada County 402, 453
Holland Mine, Nevada County 454
  Mine, Trinity County 80
Holmes Ranch deposit, Riverside County 551
Holseman Mine, Nevada County 454
Home Mine, Nevada County 454
  Ticket Mine, Nevada County 454
Homestake and Horseshoe Mine, Trinity County 80
  Mine, Nevada County 454
Homeward Bound Mine, Nevada County 454
Hook and Ladder Mine, Trinity County 80
Hoopa Coal Mining Co. 507
  Indian Gold Mines, Humboldt County 510
  Indian Reservation, Humboldt County 505, 510
Hooper, A. E., Mine, Nevada County 454
Hopkins Mine, Nevada County 454
  , T. C., Forstner, Wm., Naramore, C., and Eddy, L. H., cited 322
Horse Mountain Copper Glance Consolidated Mines, Humboldt County (see Horse Mountain Copper Co.) 505, 507
Horseshoe and Homestake Mine, Trinity County 80
  Bend Mine, Trinity County 80
  Mine, Nevada County 454
Hot Water Mine, Nevada County 403
Houghton Bros., Mine, Fresno County 566
Houston Hill Mine, Nevada County 454
Howard and Campbell Mine, Trinity County 80
  Hill Mine, Nevada County 454
Howe, R. M., and J. S. McDowell, cited 347
Hubbard, Henry G. 492, 603
  , H. G., cited 565
Hubnerite 238
Hudson Bay Mine, Nevada County 454
Hughes and Paulson Mine, Trinity County 85
  , E. Herbert, cited 513
  Mine, Nevada County 454
Huguenin, E., cited 16, 344
  , E., Cloudman, H. C., and Merrill, F. J. H., cited 285, 286, 287, 289, 290, 291, 306, 307, 308, 309, 316, 321
  , E., and C. A. Waring, cited 295, 298, 310, 312, 326
Hulin, C. D., cited 288, 291, 323
Hull, Tom, Humboldt County 527
Humboldt Artesian mineral well, Humboldt County 520
  County, barite in 504
  County, black sand in 504
  County, brick and tile in 505

Page
Humboldt Artesian mineral well, Humboldt County—Continued
County, chromium in 505
County, clay in 506
County, climate of 499
County, coal in 506
County, copper in 507
County, geography of 499
County, geology of 501
County, gold in 508
County, history of 499
County, industries of 500
County, iron in 516
County, limestone in 516
County, manganese in 518
County, mercury in 519
County, mineral production of 502
County, mineral resources of 499, 501
County, mineral water in 519
County, natural gas in 520
County, petroleum in 521
County, platinum in 526
County, quicksilver in 527
County, sand, gravel and crushed rock in 527
County, tin in 550
County, transportation to 499
Mine, Trinity County 29, 47, 80
Placer Mining Co. 29, 40
Hunter Mine, Trinity County 80
Hupp and McMurray Mine, Trinity County 83
Mine, Trinity County 80
Hussey Ledge Mine, Nevada County 454
Hyampom Valley Mine, Trinity County 80
Hydraulic Hill Mine, Trinity County 80
I. X. L. claim, Madera County 314
I. X. L. Mine, Nevada County 455
Iaqua Medicinal Spring, Humboldt County 520
Idaho Maryland Mine, Nevada County 454
-Maryland Mines Co. 380
-Maryland Mines Corp. 403
-Maryland Mines, Nevada County, photograph of 405
Ideal Group, Kern County 576
Illinois Consolidated Mine, Nevada County 454
Mine, Nevada County 454
and Wisconsin Mine, Nevada County 467
Imperial Metals, Inc. 569
Income and Indiana Mine, Nevada County 454
Independence claim, Nevada County 385, 388, 454
, Defiance and Thompson Mines, Inyo County 566
Index Mine, Trinity County 80
Indian Boy Mine, Nevada County 454
Creek Mine, Trinity County 40, 80
Indiana and Income Mine, Nevada County 454
Mine, Nevada County 454
Industries of Humboldt County 500
Ingleside Mine, Trinity County 81
Ingram, Coumbs, and Wallace Mine, Trinity County 77
Inkerman Mine, Nevada County 454
Inkmarque Group, Nevada County 454
Innis Dredging Co. 434
Integral Mine, Trinity County 81
Quicksilver Mine, Trinity County 18, 72, 81
Interstate Mine, Trinity County 81
Mines, Inc. 40
Inyo County, pyrophyllite in 194
County, stolzite in 602
County, tin in 550
County, tungsten in 310, 567
Iodine 353
Iowa Consolidated Mine, Nevada County 386, 455
, Nob Hill and Contact Mine, Nevada County 454
Irelan, W., cited 552
Iron-Copper Mine, Nevada County 455
Duke Mine, Trinity County 81
Mountain Mine, Nevada County 455
Ironclad Mine, Nevada County 455
Iron in Humboldt County 516
Isabel Mine, Trinity County 81
Island Copper Co. 23
Copper Co., photograph of mine, Trinity County 24
Copper Mine, Trinity County 81
Ivy Gulch Mine, Trinity County 81
Jack Rabbit Mill and Mining Co. 455
Ranch Mine, Tulare County (see Tungstore Mine) 318
Tar Mine, Trinity County 81
Jacobs Estate Property, Trinity County 51
Mine, Trinity County 81

Page
Jacoby Creek deposit, Humboldt County 516
Mine, Trinity County 81
Jackson Mine, Nevada County 385
January, Lent and Cotton King Mines, Nevada County 448
Jefferson Cons. Mine, Nevada County 455
Jenkins, Olaf P. 90, 202, 205, 469, 529
, Olaf P., cited 99, 100
Jennette and Gwynne Mines, Kern County 575
Jennings Gulch Mine, Trinity County 81
Jeremiah Mine, Nevada County 455
Jersey Lily Group, San Bernardino County 288
Jerusalem Mine, Trinity County 81
Jesse Consolidated Mine, Nevada County 455
Jewell Consolidated Mine, Nevada County 455
Jim and Central Mine, Nevada County 447
Consolidated Mine, Nevada County 408, 455
Johanna Mine, Nevada County 455
Johnson, Bertrand L. 332
Mine, Nevada County 455
Mine, Trinity County 81
Point Mine, Trinity County 81
and White Mine, Nevada County 467
Johnston deposit, Humboldt County 517
Jones Bros., Asbestos Supply Co. 16
Bros.' Mine, Trinity County 81
, F. L., and Fink, Colin G., cited 322
Joseph, T. L., and Edmund S. Leaver, cited 344
Warren Mine, Nevada County 455
Josephine Lode Mine, Nevada County 455
Helen Mine, Nevada County 455
Joss Mine, Trinity County 81
Joy Mine, Trinity County 81
Judd, O'Keefe, Tilden Mine, Nevada County 466
July Chrome claim, Trinity County 19
Jumbo claim, Trinity County 54, 81
Mine, Inyo County 569
Mine, Nevada County 455
Junction City Mine, Trinity County 81
City Mining Co. 40
City Mining Co., photograph of dredge 41
Just in Time Mine, Trinity County 81
Kate Hays Mine, Nevada County 455
Katie Foley Mine, Trinity County 81
Kaufield and McKinley dragline dredger, photograph of 435
and McKinley dragline dredge, Nevada County 434
Keating Mine, Trinity County 81
Keller Mine, Nevada County 455
Kellogg Mine, Nevada County 455
, John L., and Ransome, Alfred L., cited 324
, John L., cited 100
, L. O., cited 323
Kelly Mine, Trinity County 81
Mine, Trinity County 42, 81
Keno Mine, Trinity County 81
Kenosha Mine, Nevada County 455
Kennebec Consolidated Mine, Nevada County 455
Kentuck and U. S. Grant Mine, Nevada County 455
Kentucky Mine, Nevada County 455
Keogh Group, Inyo County 569
Kern County, montmorillonite in 602
County, pyrostilpnite in 194
County, scheelite in 578
County, tungsten in 312, 575
County, valentinite crystals in 602
Kernville District, tungsten deposits in 300
Kerr, Paul F., cited 323
Keystone Mine, Nevada County 455
Mine, Trinity County 81
Kilroy, Mathew Mine, Nevada County 455
Kindred and McKnight Mine, Trinity County 83
King Bee Mine, Nevada County 455
Hill Mine, Nevada County 455
and Foggarty Mine, Trinity County 78
Hydraulic Mine, Trinity County 81
Kinsman, J. C., and W. O. claims, San Bernardino County 306
Kirkham Mine, Nevada County 455
Kise and Dock Mine, Trinity County 77
Klamath Mountains province, chromite in 116
View Group, Humboldt County 510
Klondike claim, Trinity County 48
Knopf, A., cited 293, 294, 295, 296, 299, 310, 323
Koon Mine, Trinity County 81
Kruttschnitt, J., Jr., A. Hausmann, W. E. Thorn and Edman, J. A., cited 308, 322
Kyanite in Riverside County 194

Page
LaBelle and McKinley claims, Nevada County 408
    and McKinley Mine, Nevada County 455
Laboratory 194, 365, 491, 602
La Bruja Mine, Nevada County 455
La Clair Mine, Trinity County 81
Ladd Mine, Trinity County 81
Ladder and Hook Mine, Trinity County 80
Lafayette Mine, Nevada County 455
La Grande Mine, Nevada County 455
La Grange Mine, Trinity County 81
    Placer Mines, Ltd. 43
    Mine, Trinity County, photograph of 44
Laizure, C. McK. 7, 201, 373
    , C. McK., cited 314, 323, 552
Lake Mine, Nevada County 455
Lamarque Consolidated Mine, Nevada County 456
Land and Neuralgaline Mine, Nevada County 459
Lappin Lapman Mine Trinity County (see also Calmich Mine) 81
Larimer Mine, Nevada County 456
Larsen, E. S., and Frank L. Hess, cited
    295, 296, 299, 301, 302, 303, 305, 310, 315, 317, 318, 323
    Mine, Trinity County 81
Lary Mine, Trinity County 45, 81
Last Chance Mine, Nevada County 456
    Chance Mine, Trinity County 82
La Suetre Mine, Nevada County 456
Laurel Mine, Trinity County 82
Lava Cap Gold Mining Corp., mining methods and costs of the 409
    Cap Gold Mining Corp., photograph of headframe of 414
    Cap Mine, Nevada County 456
Laws Mine, Trinity County 82
    , New Mining 483
Lawyer, A. M., cited 14
Layman Mine, Trinity County 49, 82
Leaver, R. S., and T. L. Joseph, cited 344
LeCompton Mine, Nevada County 385, 456
Le Due Mine, Nevada County 456
Lemmon, D. W., cited 297, 299, 323
    Dwight M., and John V. N. Dorr, 2d, cited 253, 254, 257, 287, 324
Lenhart, Walter B., cited 298, 324
Lent, January and Cotton King Mines, Nevada County 448
Levy, S. I., cited 324
Lewiston Dredge, Trinity County 82
    Gold Dredging Co. 45, 82
    Gold Dredging Co., dredge, photograph of 45
Liberty Bell Mine, Trinity County 82
    Group, Nevada County 425
    Hill Mine, Nevada County 456
    Mine, Humboldt County 510
    Mine, Trinity County 82
Library 195, 366, 492, 603
Lila Mine, Trinity County 82
Limekiln Mine, Nevada County 456
Limestone in Humboldt County 515
    in Trinity County 67
Lincoln Consolidated Mine, Nevada County 457
    Gold Dredging Co. 45, 82
    Gold Dredging Co., dredge, photograph of 46
Linda Marie Mine, Trinity County 82
Linden Mine, Nevada County 456
Lindgren, Waldemar, cited 324, 410
Lindley claim, Nevada County 388
Lindsay Mine, Nevada County 456
Liscom Hill deposit, Humboldt County 504
Lister Mine, Trinity County 82
Little Alice Mine, Trinity County (see also Little Annie) 82, 85
    Ann Chrome Mine, Trinity County 18, 82
    Annie Mine, Trinity County (see Little Alice)
    Buster Mine, Trinity County 82
    Creek Mine, Trinity County 82
    Dick & Good Hope Group, Kern County 301
    Done claim, Nevada County 388, 456
    H. S., cited 36, 55
    Joe Mine, Trinity County 82
    McGee Creek Tungsten Mine, Inyo County 570
    Task Mine, Nevada County 456
Live Oak Mine, Nevada County 456
    Oak and St. Mary's Mine, Trinity County 87
    Oat and Minuet Mines, Nevada County 456
    Yankee Mine, Nevada County 456
    Yankee and Perseverance Mine, Nevada County 461
Lizard, Wasp, Summit and South Centennial Mine, Nevada County 464
Locarno-Simon Group, Kern County 576
Lode Star Mine, Nevada County 456

Page
Log Cabin Bar Mine, Trinity County 82
Cabin Mine, Trinity County 82
Logan, C. A., 7, 201, 373
, C. A., cited 16, 344, 526, 552
Lombard and Main Group, San Bernardino County 307
Lone Jack Mine, Nevada County 456
Ridge Mine, Nevada County 456
Star claim, Trinity County 48, 456
Long Gulch Mine, Trinity County 82
Mine, Trinity County 82
Loofbourrow clay deposit, Humboldt County 506
Lorenz Mine, Trinity County 82
Los Angeles Field District 7, 201, 373
Lost Dog Mine, Trinity County 19, 82
Hope Group, Nevada County 456
Horse Mine, Trinity County 82
Lotzen Ranch Mine, Nevada County 456
Loutzenheiser Tract Mine, Nevada County 456
Lower Buckeye Mine, Trinity County 82
Dutton's Creek Mine, Trinity County 82
Lucky Al Cons. Mine, Nevada County 456
Mack Mine, Trinity County 82
Mine, Nevada County 456
Strike and Effie Bell Mine, Trinity County 82
Strike Mine, Trinity County 82
Swede claim, Trinity County 58
Lund, Richard J., cited 324
McAtee Bar Mine, Trinity County 83
McClaren Group, Trinity County 48, 83
McClary and Bloss Mine, Trinity County 75
McClellan deposit, Humboldt County 517
McCraney, Orlando, cited 388
McDonald, J. A., Mine, Trinity County 83
Mine, Trinity County 83
, P. B., cited 316, 324
McDowell, J. S., cited 347
, J. S., and Howe, R. M., cited 347
McGain, Roy, cited 513, 514
McGilivary Mine, Trinity County 83
McIlwaine and Colby Mine, Trinity County 76
Mine, Trinity County 83
McKay Mine, Nevada County 457
and Abbott Mine, Trinity County 83
McKenzie and Timmerman Mine, Trinity County 87
McKinley and Kaufield dragline dredger, photograph of 435
and Kaufield dragline, Nevada County 434
and La Belle Mine, Nevada County 408, 455
McKnight and Kindred Mine, Trinity County 83
Group, Trinity County 67
McLaughlin, R. P., and Walter W. Bradley, cited 314, 324
McMurray and Hupp Mine, Trinity County 83
Maben Hill Mine, Nevada County 425
MacDonald, D. F., cited 10, 12
MacNamara Mine, Trinity County 82
Mac Van claim, Inyo County 295
Macon and United Banner, and United Eagle Mine, Nevada County 466
Madera County, tungsten in 313, 580
Madison Hill Mine, Nevada County 457
Magenta Mine, Nevada County 457
Magnesite 345
, bibliography of 347
, buyers of 346
, markets for 346
, occurrence of 345
, preparation of 345
, properties of 345
, tests of 346
Magnesium Canyon Mine, Riverside County 582
salts 354
Mahoney and Wallace Mine, Trinity County 82
Maier, C. G., cited 344
Main and Lombard Group, San Bernardino County 307
Burnett Property, El Dorado County 138
Majestic Mine, Trinity County 29, 82
Mines Co. 47
Malony and Fouch Mine, Nevada County 457
Maltos, Green and Volente Mine, Trinity County 83
Mammoth Gold Copper Mine, Nevada County 457
Group, Nevada County 457
, Siskiyou County 123
Manganese 342
, bibliography of 344
and chrome ore, new specifications and prices 589
, buyers of 344
, classification of 342

Page
Manganese—Continued
  in Humboldt County ----- 518
  in Nevada County ----- 441
  in Trinity County ----- 67
  , markets for ----- 343
  , occurrence of ----- 342
  , properties of ----- 342
  , tests for ----- 343
  , uses of ----- 343
Manhattan Mine, Nevada County ----- 457
Mann, W. H., Property, San Bernardino County ----- 288
Map of tungsten resources of California ----- 243
Maple claim, Trinity County ----- 47, 83
  Creek deposit, Humboldt County ----- 507
  Creek Mine, Trinity County ----- 83
  Mine, Nevada County ----- 457
Marble in Trinity County ----- 67
Marcellus Group, Trinity County ----- 47, 83
Marguerite Mine, Nevada County ----- 457
Margy claim, Del Norte County ----- 118
Marietta Mine, Nevada County ----- 457
Maringer Chrome Mine, Trinity County ----- 83
Mariposa County, apatite in ----- 491, 60
  County, garnierite in ----- 491
  County, tungsten in ----- 580
  County, gersdorffite in ----- 491, 602
Marketing talc, pyrophyllite and ground soapstone ----- 332
Marsman Co., of California ----- 426
Martin, A. H., cited ----- 290, 324
  Mine, Trinity County ----- 83
Mary Ann Mine, Nevada County ----- 457
Maryland Mine, Nevada County ----- 457
Mascot Mine, Nevada County ----- 457
Mason and Thayer Mine, Trinity County ----- 83
Massachusetts Mine, Nevada County ----- 457
Matlock and Bower Mine, Trinity County ----- 75
Mauldin and Bateman Mine, Trinity County ----- 74
Maule Mine, Nevada County ----- 457
Maybert Gold Mines, Nevada County ----- 457
May Blossom Mine, Trinity County ----- 83
Mayflower Dewey Mine, Nevada County ----- 457
  and Baltimore Mine, Nevada County ----- 457
  Mine, Nevada County ----- 457
Meckel and Schlomer Mine, Trinity County ----- 86
  -Fields Property, Trinity County ----- 48, 78, 83
  Mine, Trinity County ----- 83
Mercer Fraser Co. ----- 527
  Fraser Co., photograph of Worswick plant ----- 527
Mercury in Humboldt County (see quicksilver) ----- 519
Merrifield Mine, Nevada County ----- 457
Merrill, Chas. White ----- 90, 91
  , Chas. White, cited ----- 91, 228, 324
  , F. J. H., cited ----- 550, 552
  , F. J. H., H. C. Cloudman and E. Huguenin, cited ----- 321
Merrimac Mine, Nevada County ----- 457
Mescall, San Luis Obispo County ----- 161
Methods of treating tungsten ores ----- 270
Metropolitan Mine, Nevada County ----- 457
Mexican Consolidated Mine, Nevada County ----- 457
Midas and Yuba Mother Lode Mine, Nevada County ----- 457
Mike Smith Mine, Trinity County ----- 83
Miller, Wm. J., and Robert W. Webb, cited ----- 324
Millerite in Ventura County ----- 491, 602
Minaret Mine, Trinity County ----- 83
Mineral Hill Mine, Nevada County ----- 457
  King Mine, Nevada County ----- 457
  paint in Nevada County ----- 442
  paint in Trinity County ----- 69
  production of Humboldt County ----- 502
  production of Trinity County ----- 14
  resources of Humboldt County ----- 499, 501
  resources of Nevada County ----- 374
  resources of Trinity County ----- 8, 11
  water in Humboldt County ----- 519
  water in Trinity County ----- 69
Mineralogy of tin ----- 544
  of tungsten ----- 237
Minerals and statistics ----- 191, 349, 487, 598
  containing tungsten ----- 237
Minersville Mine, Trinity County ----- 83
Mines Exploration Co. ----- 28, 48, 83
Mining and Scientific Press, cited ----- 388, 390
  Journal, The, cited ----- 293, 300, 303, 313, 319, 324
  Laws, new ----- 483
  methods and costs at the Lava Cap Gold Mining Corp. ----- 409
Minnesota Mine, Nevada County ----- 457

Page

Minnie and Rush Mine, Nevada County 463
  Mine, Nevada County 457
  May claim, Trinity County 54
Mintern Group, Kern County 576
Minuet and Live Oak Mines, Nevada County 456
Mistletoe Mine, Nevada County 457
Mitchell Ranch, Nevada County 457
Moccasin Mine, Siskiyou County 330
  Mine, Siskiyou County, photograph of 329, 330
Modoc Gold Mine, Trinity County (see also Wagner) 48, 83
  Gold Mines, Inc. 48
  Mine, Nevada County 457
  Mine, Trinity County 83
Moffat Creek, Siskiyou County 126
Mohawk Mine, Nevada County 457
Mohigan Group, Nevada County 458
Mojave Annex Mine, San Bernardino County 307
Mojave Tungsten Mine, San Bernardino County 307
Molitor Mine, Trinity County 49, 83
Monarch Mine, Nevada County 458
  Mine, Trinity County 83
  Rand Mine, Kern County 576
  Tungsten Gold Mining Co. 288
  Tungsten Mine, Inyo County 311
Monk Mine, Trinity County 83
Mono County, scheelite in 581
  County, tungsten in 314, 581
Montana Mine, Nevada County 458
Monte Carlo Mine, Nevada County 458
  Christo and Apple Tree Mine, Trinity County 83
  Rio River Mine, Nevada County 458
Montezuma claim, Trinity County 53, 83
Montmorillonite in Kern County 602
Montreal Mine, Nevada County 458
Moonbeam No. 1, San Luis Obispo County 141
Moore tin deposit, Riverside County 551
Morehouse Mine, Nevada County 458
Morning Dew Mine, Nevada County 458
  Star Group, Nevada County 458
  Star Lode Mine, Nevada County 458
  Star Mine, Trinity County 83
Morris claims, Inyo County 295
  Mine, Trinity County 83
  , William, Mine, Trinity County 83
Morrison Gulch Mine, Trinity County 83
Moscatelli Bob Mine, Nevada County 458
  Pete Mine, Nevada County 458
Moscow Mine, Nevada County 458
Mother Neal Mine, Nevada County 458
Mount Auburn Mine, Nevada County 458
  George Mine, Nevada County 458
  Hill Mine, Nevada County 458
  Hope and Golden Age Mine, Nevada County 458
  Morensis and Railroad Mine, Trinity County 85
  Vernon Mine, Nevada County (see also Home or Native Son) 426, 458
Mountain Boomer Mine, Trinity County 49, 83
  Kid Group, Inyo County 570
  Maid Mine, Nevada County 458
  View Mine, Kern County 577
  View Mine, Nevada County 458
  View springs, Humboldt County 520
Mountaineer Mine, Nevada County 458
Mouth of Weaver Mine, Trinity County 83
Mueller Mine, Trinity County (see also Layman) 49, 83
Mule Creek and Cement Mine, Trinity County 76
  Spring Ranch Placer claim, Nevada County 434
  Trail Placer, Humboldt County 510
Muller and Purcell Mine, Nevada County 462
  and Wallings Mine, Nevada County 458
Mumbo Creek Mine, Trinity County 84
Mumsie A. Chrome Mine, Trinity County 18, 19, 84
Munko, J. A., Mercury Mine, Trinity County 19, 84
Murchie Mine, Nevada County 380, 458
Murray Mine, Humboldt County (see Nelson) 511
  Mine, Humboldt County, photograph of 511
Museum 191, 363, 487, 599
Mystery Mine, Nevada County 458
Nahcolite in San Bernardino County 194
Nancy Lee claim, Trinity County 36
Naphis Peak Mine, Trinity County 84
Naramore, C., Wm. Forstner, T. C. Hopkins and L. H. Eddy, cited 316, 322
Nash Mine, Trinity County 50, 84
National Group, Nevada County 458
  Mine, Nevada County 459
Native Son Lode Mine, Nevada County 459

Page

Natural Gas in Humboldt County 520
Navigable Streams, power permits on U. S. Supreme Court decision 169
Negunda Mine, Trinity County 84
Nellie May Mine, Trinity County 84
Nelson Gulch Mine, Trinity County 85
Neuralgaline and Land Mine, Nevada County 459
Nevada City and Grass Valley District, Nevada County, map of, back cover of report.
  City Mine, Nevada County 459
  County, asbestos in 378
  County, barite in 378
  County, chromite in 379
  County, copper in 379
  County, garnet in 380
  County, geography of 374
  County, geology of 375
  County, index map of 374
  County, manganese in 441
  County, map of, back cover of report.
  County, map of western portion of, back cover of report.
  County, mineral paint in 442
  County, mineral production of 376
  County, mineral resources of 374
  County, sand and gravel in 443
  County, tungsten in 315, 443
  County, water, power and timber in 375
  County Mine, Nevada County 459
  Lode Mine, Nevada County 459
  Mine, Nevada County 459
Never Give Up Mine, Nevada County 459
  Sweat Mine, Nevada County 459
New Blue Jay Mining Co. 84
  Brunswick Mine, Nevada County 380, 459
  Constitution Mine, Nevada County 459
  Discovery Mine, Trinity County 84
  Dorn Hill Mine, Nevada County 459
  England Consolidated Mines, Nevada County 459
  Eureka Mine, Nevada County 459
  Hope Mine, Nevada County 459
  Idea Mine, Nevada County 459
  London, San Luis Obispo County 162
  Mining Laws 483
  Manganese and chrome ore specifications and prices 589
  Mohawk Consolidated Mine, Nevada County 459
  Ophir Mine, Nevada County 459
  Pittsburg Mine, Nevada County 459
  Providence Mine, Nevada County 459
  River Co. 84
  River Mine, Trinity County 50, 84
  River Mining and Development Co. 50
  Rocky Bar Mine, Nevada County 459
  Year's Mine, Nevada County 459
  York Hill Mine, Nevada County 459
  York Mine, Nevada County 459
Newtown Mine, Nevada County 459
Niagara Mine, Nevada County 459
Nichols Group, Nevada County 459
  Mine, Humboldt County 512
Nickel and cobalt, history of the names 473
Niedra Group, Trinity County 51, 84
Niggerhead claim, Del Norte County 118
  , San Luis Obispo County 162
Nigger Hill Mine, Trinity County 84
Nitrates 355
Nob Hill, Iowa and Contact Mine, Nevada County 454
Nobs, F. W., cited 315
Nonpareil Mine, Trinity County 84
Norambagua Group, Nevada County 459
Norcross, San Luis Obispo County 143
Normandie-Dulmaine claims, Nevada County 426, 459
North Banner Consolidated Mine, Nevada County 459
  Bloomfield Mine, Nevada County 460
  Central Area, El Dorado County 137
  Counties Oil Co. 526
  Fork Placers, Trinity County 52, 84
  Grant claim, Nevada County 388
  Grant Consolidated Mine, Nevada County 460
  Mammoth Mine, Nevada County 460
  of Seiad claims, Siskiyou County 124
  San Juan Manufacturing Co. 460
  Star and Evening Star claims, Trinity County 53
  Star Mine, Nevada County 380, 460
  Star Mine, Trinity County 84
  Star Mines, Nevada County, flow sheet of 396
  Star and Empire Mines, Nevada County 315
  Wyoming Mine, Nevada County 460

Page
Northern Bell Group, Nevada County 460
    Bell and Thomas claims, Nevada County 427
    California Mines Co. 51, 84
    claims, Siskiyou County 127
Northwest Basin, El Dorado County 137
    Group, San Luis Obispo County 139
Norton Mine, Nevada County 385
Norway Mine, Nevada County 460
Nugget Bar Mine, Trinity County 84
Number Three Mine, Nevada County 460
O. K. and Gold Bar Mine, Nevada County 460
    Mine, Nevada County 460
Oak Flat Mine, Nevada County 460
    Grove Tungsten Mine, San Diego County 318
Oakland claim, Nevada County 427, 460
Oakman Group, Nevada County 460
O'Brien, John C. 195, 366, 373
    , John C., cited 565
Ocean Star Mine, Nevada County 427, 460
Occurrence of scheelite in Idaho-Maryland Mines, Nevada County 224
O'Connell Mine, Trinity County 84
Of What Nos. 1 and 2 Mine, Nevada County 460
Ohio and Wheeling, West Virginia Mine, Nevada County 467
Oil and gas, occurrence of 469
O'Keefe, Tilden and Judd Mine, Nevada County 466
Olcott, Harrison and Bryant Mines, Nevada County 453
Old Bill Property, Trinity County 68, 84
    Bones Mine, Trinity County (see also Shock Mine) 84
    Hickey claim, Trinity County 54
    Hickey No. 1 claim, Trinity County 54
    Home Mine, Nevada County 460
    Houston Mine, Nevada County 460
    Mack Lode and Young Mack Mine, Nevada County 468
Omaha Mine, Nevada County 460
O'Meara, R. G., and J. Clemmer, cited 321
Omega Mine, Nevada County 460
    Hydraulic Mine, Nevada County 433
O'Neill Mine, Trinity County 84
Ophir Mine, Nevada County 460
Orange County, tin in 550
Oregon Gulch Mine, Trinity County 84
    Mine, Nevada County 460
Original Ben Franklin Consolidated Mines, Nevada County 460
    Empire Mine, Nevada County 460
    Pittsburg Mine, Nevada County 461
Oriole Property, Trinity County 62, 84
Orion Consolidated Mine, Nevada County 461
Orleans Consolidated Mine, Nevada County 461
    Mine, Nevada County 461
    No. 3 Lode Mine, Nevada County 461
    Placer Mine, Humboldt County (see Bar Placer Mining Co., and Stoney Bar Mining Co.) 512
Oro Corona Mine, Trinity County 84
    Fino and Congo Mine, Nevada County 461
    Fino Mine, Nevada County 461
    Grande Mine, Nevada County 461
    Grande Mine, Trinity County 84, 461
    Trinity Dredge, Trinity County 84
Osborn, W. X., cited 324
Osborne Hill Mine, Nevada County 461
Osceola Mine, Nevada County 461
Osdick Group, San Bernardino County 288
O'Shay Mine, Trinity County 84
Ott, Rudolph, Mine, Trinity County 84
Oustomah Mine, Nevada County 461
Overland Mine, Trinity County 84
Oversight Fraction claim, Trinity County 49
Owl Mine, Humboldt County 512
    Mine, Kern County 577
Oxford Mine, Nevada County 461
Ozark Mine, Trinity County 84
Pabst, Adolph, cited 324, 552
Pacific Gold Dredging Co. 85
    Mine, Nevada County 461
    Mine, Trinity County 29, 47
    Tungsten Co. 570
Paine claims, Nevada County 461
    Mine, Nevada County 461
Pallestreau Mine, Trinity County 85
Panama Lode Mine, Nevada County 461
Pansy Placer Mine, Trinity County 53, 85
Panwocket Mine, Trinity County 85
Panyo Tungsten Mine, Inyo County 571
Paradise Mountains tungsten deposit, San Bernardino County 585
Parlier Prospecting Association claim, Fresno County 566

Page
Parr Mine, Nevada County 461
Partridge, Jr., John F. 225
Pascoe, Cecil and Clarence Group, Kern County 313
Patillo Property, Trinity County 53, 85
Paulson and Hughes Mine, Trinity County 85
  Hydraulic Mine, Trinity County 85
Pawnee Mine, Riverside County (see Carr) 583
Paymaster mill, Trinity County, photograph of 54
  Mine, Trinity County 53, 85
Peabody Mine, Nevada County 461
Pearch Mine, Humboldt County 512
  Mine, Humboldt County, photograph of 513
  Mine, Humboldt County, photograph of sluice at 514
Peewee Mine, Trinity County 85
Pennsylvania Mine, Nevada County 380, 461
Pentlandite in Ventura County 491
Pepper, Plumas County 135
Perigot and Teal Mine, Trinity County 87
Perseverence and Live Yankee Mine, Nevada County 461
Perry Mine, Trinity County 85
Petroleum in Humboldt County 521
Philadelphia Mine, Nevada County 461
Phillips Mine, Trinity County 85
Phillpot Mine, Trinity County 85
Phoenix Mine, Nevada County 461
  Park Mine, Nevada County 461
Picayune Mine, Trinity County 85
Pick and Shovel, San Luis Obispo County 163
Pickett and Stofer Mine, Trinity County 85
Pike, R. D., and L. H. Duschak, O. C. Ralston, cited 347
Pillikin Group, El Dorado County 136
Pilot Hill, El Dorado County 135
Pine Creek Tungsten Mine, Inyo County 572
  Creek Tungsten Mine, Inyo County, photograph of 247
  Hill Mine, Nevada County 461
  Tree Mine, Kern County 577
  Tree Mine, Nevada County 461
  Tree Mine, Trinity County (see also Upham Hydraulic Mine) 85
Pink Crystal claim, Trinity County 19, 85
Pinnacle and Dewey Electrum Mine, Nevada County 449
Pioneer Mine, Nevada County (see also Mitchell Ranch) 443, 461
Pittsburg Comstock Mine, Trinity County 85
  Group, Nevada County 461
Placer Development Co. 54, 85
  Gold Co. 28[illegible]
Planet claim, Nevada County 434
Plate, H. R., cited 430
Platinum in Humboldt County 526
  in Trinity County 69
Plumas County, chromite in 135
  County, tin in 550
  County, tungsten in 581
  Lode Mine, Nevada County 461
  Nevada Mine, Nevada County 462
Plummer Gulch Mine, Trinity County 85
Poison Gulch Mine, Trinity County 85
Poker Bar Mine, Trinity County 85
Polar Star Mine, Nevada County 462
Polaris Mine, Nevada County 462
Polinghorn Mine, Nevada County 462
Pony Bar Mine, Trinity County 85
Poor Boy claim, Trinity County 55, 85
Posey Mine, Nevada County 385
Post and Wilson Mine, Trinity County 85
Potash 355
Potillo Mine, Trinity County 85
Potosi Mine, Nevada County 462
Pound Cake Mine, Trinity County 85
Poverty Flat Mine, Trinity County 85
Powellite 239
Power permits, decision of the Supreme Court 169
Powning Mine, Nevada County 462
Pratt and Dubuque Mine, Nevada County 462
Precious Twins Mine, Trinity County 85
Premier Mine, Nevada County 462
Prescott Hill Mine, Nevada County 462
Preston, E. B., cited 552
Price Mine, Trinity County 85
  of gold 437
Prices of tungsten 232
Producers and consumers 200, 371, 608
Production of tin in California 543
  of tungsten in California 278
Prospect claim, Del Norte County 121
Providence Mine, Nevada County 462

Page
Prudential Mine, Nevada County (see also Selena, Perrin and Co., or Slate Ledge) 427
Prussian and Heimburger Mine, Trinity County 85
Purcell and Muller Mine, Nevada County 462
Pyrophyllite, ground soapstone and talc, buyers of 337
  , ground soapstone and talc, markets for 335
  , ground soapstone and talc, prices of 336
  , in Inyo County 194
  , talc and ground soapstone, definition of 332
  , talc and ground soapstone, occurrence of 332
  , talc and ground soapstone, production of 333
  , talc and ground soapstone, properties of 332
  , talc and ground soapstone, sales 334
  , talc and ground soapstone, uses of 332
Pyrostilpnite in Kern County 194
Pyrrhotite in Ventura County 491
Quartz 478
  claim on Woods Ravine Mine, Nevada County 462
  in Calaveras County 491
Queen Lil Mine, Nevada County 462
  Regent Mine, Nevada County 462
Quicksilver deposits in California 562
  in Humboldt County 527
  Program of the Federal Geological Survey 558
  in Trinity County 70
Quimby Mine, Trinity County 85
Quincy Group, Plumas County 135
Quirk claims, San Bernardino County 289
R. A. M. Mine, Trinity County (see also Little Alice and Little Annie) 85
R. & M. Tungsten Mines, Madera County 580
Ragon and Hilda Mine, Nevada County 453
  Mine, Nevada County 462
Railroad Mine, Nevada County 462
  and Mount Morensis Mine, Trinity County 85
Rainbow Gold Mine, Nevada County 462
  Group, Trinity County 55, 85
Ralston Mine, Trinity County 55, 85
  , O. C., R. D. Pike and L. H. Duschak, cited 347
Rand Divide Mining Co. 386
  Group, Kern County 302
Randolph Mine, Nevada County 462
Ransome, Alfred L., and John L. Kellogg, cited 324
  Alfred L., cited 100
Raspite 239
Rastall, R. H., cited 324
Rawhide, San Luis Obispo County 161
Ray Mine, Trinity County 85
Raymond, R. W., cited 388
Readjuster claim, Trinity County 54, 85
Rebel Mine, Trinity County 85
Recent Developments in the Tungsten Resources of California 565
Redan Mine, Nevada County 462
Red Bank and Banon Mine, Trinity County 85
  Boy claim, Trinity County 49
  Cap Mine, Humboldt County 508
  Cliff Mine, Trinity County 85
  Cross Consolidated Mine, Nevada County 462
  Flat Mine, Trinity County 86
  Hill and Chamberlain Mine, Trinity County 76
  Hill Specimen Mine, Nevada County 462
  Hill Group, Glenn County 133
  Hill Mine, Nevada County 462
  Hills Mine, Trinity County 51, 86
  Ledge Consolidated Mine, Nevada County 462
  Ledge Mine, Nevada County 462
  Mountain claim, Trinity County 19, 86
  Mountain Group, Nevada County 462
  Point Mine, Nevada County 462
  Rose Mine, Nevada County 462
  Sunday and Good Friday Mine, Trinity County 79
Redding Creek Mine, Trinity County 86
  Field District 8, 201, 373, 499
Redfield claim, Trinity County 55, 56
Reese Bros,. Mine, Trinity County 22, 86
Reindeer Mine, Trinity County 86
Relief Hill Mine, Nevada County 433
Reports of District Mining Engineers 7, 201, 373, 497
Republic Group, Nevada County 462
Republic Mine, Nevada County 462
Reward Mine, Nevada County 428, 463
Rhodes and Brown deposit, Fresno County 309
Richardson Mine, Nevada County 463
Richter, Wm., and Sons 435
Rickter deposit, Humboldt County 517
Ridge and Dorsey Mine, Nevada County 449

Page
Ridgeway Mine, Trinity County 86
, Robert H., and H. W. Davis, cited 296, 324, 344
Rip Van Winkle Mine, Nevada County 463
Rising Sun Mine, Nevada County 463
Sun Mine, Trinity County 86
Ritchie, S. B., cited 324
Riverside County, kyanite in 194
County, tin in 550
County, tungsten in 582
Roannaise Mine, Nevada County 463
Rock Roche Mine, Nevada County 463
Rocky Bar Mine, Nevada County 463
Glen Mine, Nevada County 463
Roe Mine, Trinity County 86
Rogers, A. F., cited 324
Mine, Nevada County 463
Rolker, C. M., cited 550, 552
Rolph Ranch, Nevada County 378, 463
Rose Fraction Property, San Bernardino County 289
Hill Mine, Nevada County 463
Round Valley Tungsten Mine, Inyo County (see also Stevens, Borchim and Shively Group of claims) 296
Roush, G. A., cited 325
Royal Bohee Group, Kern County 289
Royer, M. B. and G. R. Fitterer, cited 344
Ruby and Spanish Mike Mine, Trinity County 86
Runner, J. J., and M. L. Hartmann, cited 325
Rush Creek Mine, Trinity County 86
and Minnie Mine, Nevada County 463
Russel Ravine Mine, Nevada County 463
Rusty claim, Nevada County 428
Sacramento Field District 7, 201, 373
Mine, Nevada County 463
Sagamore Mine, San Bernardino County 308
St. Charles Mine, Inyo County 570
Gothard Consolidated Mine, Nevada County 465
Johns Mine, Nevada County 465
Louis claim, Nevada County 385, 388, 465
Louis Consolidated Mine, Nevada County 465
Mary's and Live Oak Mine, Trinity County 87
Mine, Nevada County 463
Patrick Consolidated Mine, Nevada County 465
Stephens Mine, Nevada County 385, 465
Saline producers for 1940, directory of 359
Salmon Summit Mine, Trinity County 55, 86
Salt 356
claim, Plumas County 135
Extension, Plumas County 135
Flat Mine, Trinity County 86
Salyer Consolidated Mines Co. 55, 86
Mine, Trinity County, photograph of 56
Sam Hampton Mine, Trinity County 86
Sampson, R. J. 7, 201, 373
, R. J., cited 550, 551
, R. J., and W. B. Tucker, cited 286, 287, 291, 292, 293, 295, 296, 297, 298, 306, 307, 308, 309, 311, 312, 317, 325, 550, 551, 565
San Bernardino County, autunite in 491
County, cassiterite in 365
County, eastern district 305
County, greenockite in 194
County, nahcolite in 194
County, tin in 551
County, torbernite in 491, 602
County, tungsten in 316, 584
San Carlos Dredging Co., photograph of washing plant 436
Gold Dredging Co. 435
Sand and gravel in Nevada County 443
, gravel and crushed rock 527
Sandburg and Carlson Mine, Trinity County 76
Sanders Ledge Mine, Nevada County 463
San Diego County, tin in 552
County, tungsten in 317, 587
San Francisco County, stilbite in 365
Field District 7, 201, 373
San Jose claim, Trinity County 49
Extension claim, Trinity County 49
Mine, Nevada County 463
San Juan Mine, Nevada County 463
San Luis Obispo County, chromite in 139
San Miguel claim, Trinity County 53, 86
Santa Ana Gold Mines, Kern County 290
Anita Mine, Nevada County 463
Clara, San Luis Obispo County 162
Sauvee Mine, Nevada County 463
Scadden Flat Mine, Nevada County 463
Scandia Mine, Siskiyou County 328

Page

Schaller, Waldemar T., cited 325, 552
, W. T. and Frank L., cited 323
Scheelite 238
, does it always fluoresce? 593
, garnet-epidote ore, photograph of 248, 249
Group, Inyo County 297
Group, Kern County 290
in Calaveras County 491, 602
in Kern County 578
in Mono County 581
, Occurrence of at Idaho-Maryland Mines, Grass Valley 224
Scheelore Tungsten Mines, Mono County 581
Schlorb, Shafer and Field Group, San Bernardino County 308
Schlomberger Mine, Trinity County 86
Schlomer and Meckel Mine, Trinity County 86
Schmidt Property, Nevada County 463
Schofield Mine, Nevada County 463
Schroeder Mine, Nevada County 463
Schules Mine, Trinity County 86
Scoles claim, Nevada County, photograph of headframe of 400
Scotia Mine, Nevada County 463
Sebastopol Mine, Nevada County 463
Securities and Exchange Commission, new rules and regulations on corporations issuance of stock 184
Securities Act of 1933 184
Segerstrom, Richard J. 531
Seiad Valley, Siskiyou County 125
Selvester and Wilson Mine, Trinity County 86
Senger Mine, Trinity County 86
Seven Thirty Mine, Nevada County 463
Sewell Mine, Trinity County 57
Shadow Mountain deposits, San Bernardino County 316
Mountain Tungsten Mine, San Bernardino County 250
Shafer, Schloerb and Field Group, San Bernardino County 308
Shamrock Mine, Nevada County 463
Shannon Creek Tungsten deposit, Inyo County 298
Sharpe Mining Co., Nevada County 463
Quartz and Gravel Mining Co. 463
Shasta County, chromite deposits in 131
County, tungsten in 318, 587
Hydraulic Gold Co. 57, 86
Lilly claim, Trinity County 72, 86
Sheridan Mine, Trinity County 57, 86
Sherwood Mine, Trinity County 86
Shoofly Mine, Trinity County 86
Shorty Harris Tungsten Mine, Inyo County 574
Shovel Placers, Nevada County 436
Siegfield Mine, Trinity County 86
Sierra Asbestos Co. 378
Asbestos Mine, Nevada County 463
Nevada, chromite deposits in 134
Signal Group, Nevada County 463
Silver Bar Mine, Nevada County 463
Grey Group, Trinity County 58, 86
Horde Mine, Madera County 314
and Wisconsin Gold Mine, Nevada County 467
Star Group, San Bernardino County 585
Sims Consolidated Mine, Nevada County 463
Single Jack, San Luis Obispo County 163
Sirius Mine, Nevada County 463
Siskiyou County, chromite deposits in 123
County, dragline dredging in 328
County, tin in 552
Skaggs and Foss Group, Trinity County 68
Slate Creek Mine, Trinity County 86
Ledge Mine, Nevada County 463
Sleeping Beauty Mine, Nevada County 463
Slide Mine, Nevada County 464
Slug Group, Nevada County 464
Smith, W. B., Mine, Nevada County 464
Creek and Gibson Mine, Trinity County 86
Cromwell Mine, Trinity County 86
, Mike, Mine, Trinity County 83
Mine, Trinity County 86
Smuggler and Union Jack Mine, Nevada County 466
Sneath and Clay Mine, Nevada County 464
Snowflake Mine, Nevada County 464
Snow Gulch Mine, Trinity County 86
Shoe claim, Trinity County 53
Soapstone, ground, pyrophyllite and talc, production of 333
, ground, talc and pyrophyllite, markets for 335
, ground, talc and pyrophyllite, prices of 336
, ground, talc and pyrophyllite, properties of 332
, ground, talc and pyrophyllite, sales 334
, ground, talc and pyrophyllite, uses of 332

Page

Soda 357
Solace Mine, Nevada County 464
Soldier's Wells Group, Nevada County 119
Somerset Mine, Nevada County 464
Sonntag Ranch Mine, Nevada County 464
South Banner Mine, Nevada County 464
    Block Tin, Group, Riverside County 551
    End Mine, Nevada County 464
    Fork Mine, Trinity County (see Swanson Mining Corp.) 56, 87
    Idaho Consolidated Mine, Nevada County 464
    Star Group, Nevada County 464
    Yuba Mine, Nevada County 464
Southeast Basin, El Dorado County 137
    Group, San Luis Obispo County 144
Southeastern Railroad Property, El Dorado County 138
Southern California, chromite deposits in, 139
    claims, Siskiyou County 126
Sowden Mine, Trinity County 87
Spanish barite deposit, Nevada County 378
    Mike and Ruby Mine, Trinity County 86
    Mine, Nevada County 428, 464
    Hill Mine, Nevada County 464
Special Articles 168, 327, 471, 564
Spence Mineral Mine, Nevada County 464
Spider Group, Trinity County 68, 87
Spion Kop Lode Mine, Nevada County 464
Spring Hill Gold Mines, Inc. 429
    Hill Mine, Nevada County, photograph of headframe and mill 430
Stacey Mine, Nevada County 464
Standard Group, Nevada County 464
    Tungsten Mine, San Bernardino County 585
Stanford claim, San Bernardino County, photograph of 246
Star Dust Group, San Bernardino County 586
    Ledge Group, Nevada County 464
    Light Mine, Nevada County 465
    of the East Mine, Trinity County 87
Starlight Mine, Nevada County 465
    , San Luis Obispo County 142
Starr Group, Nevada County 465
Statistics and minerals 191, 349, 487, 598
Starvation Mine, Trinity County 59, 87
Steele Mine, Nevada County 465
    Property, El Dorado County 138
Steep Hollow claim, Nevada County 434
Steephollow Group, Nevada County 465
Steiner's Flat Mine, Trinity County 87
Stem Winder, Etna Mine, Nevada County 465
Stevens Gulch Mine, Trinity County 87
Stevenson, John S., cited 325
Stick to it Mine, Trinity County 87
Stilbite in San Francisco County 365
Stiller Mine, Trinity County 87
Stock and Buck Placer Mine, Nevada County 434
    issuance, new rules and regulations by Securities and Exchange Commission 184
Stockbridge Mine, Nevada County 465
Stockton Hill Mine, Nevada County 465
    Mine, Nevada County 465
Stofer and Pickett Mine, Trinity County 85
Stolzite 239
    in Inyo County 602
Stonewall Jackson Mine, Nevada County 465
Storms, W. H., cited 325, 550
Strategic importance of tungsten 235
    Minerals Procurement 91
Strode Mine, Trinity County (see also Oro Grande) 87
Stuart and Wheaton Mine, Trinity County 89
    Fork Mine, Trinity County 87
Sturdivant Mine, Trinity County 87
Sultana Mine, Nevada County 465
Summit claim, Trinity County 19, 87
    Consolidated Gold Mining Co. 465
    Lime Co. 578
Sundown Mine, San Diego County 587
Sunny Slope claim, Trinity County 19, 87
    South Mine, Nevada County 465
Sunnyside and Bulah Mine, Nevada County 465
    Mine, San Bernardino County (see also Lvingston and Morongo King) 586
Sunrise Mine, Nevada County 465
    No. 1, San Luis Obispo County 142
    No. 2 Mine, San Luis Obispo County 142
    No. 3 Mine, San Luis Obispo County 142
Sunset Group, Kern County 313
    Mine, Nevada County 465

Page

- Sunshine Mine, Trinity County 87
  - prospect, Kern County 290
- Supplanter Mine, Trinity County 87
- Supreme Court, U. S., renders far-reaching decision on power permits on navigable streams 169
- Swanson Mining Corp. 56, 59, 87
  - Mining Corp., cited 56, 60
  - Mining Corp. Property, Trinity County, photograph of 60, 61
- Sweet Ranch Mine, Nevada County 465
- Sweetwater, San Luis Obispo County 140
- Sylvanite Group, Nevada County 465
- Symons, Henry H. 191, 349, 487, 598
  - , Henry H., cited 282, 288, 291, 293, 296, 297, 309, 325, 550
- Syndicate Consolidated Group, Nevada County 465
- T and O Mine, Trinity County 87
- Talc, marketing, pyrophyllite and ground soapstone 332
  - , pyrophyllite and ground soapstone, buyers of 337
  - , pyrophyllite and ground soapstone, definition of 332
  - , pyrophyllite and ground soapstone, markets for 335
  - , pyrophyllite and ground soapstone, occurrence of 332
  - , pyrophyllite and ground soapstone, prices of 336
  - , pyrophyllite and ground soapstone, properties of 332
  - , pyrophyllite and ground soapstone, sales 334
  - , pyrophyllite and ground soapstone, uses of 332
- Taliaferro, N. L., cited 135
- Tanner Mine, Trinity County 87
- Taylor Mine, Nevada County 465
  - Mine, Nevada County (see also Iron Mountain) 442
- Teddy Mine, Nevada County 465
- Telegraph Mine, Nevada County 465
- Teal and Perigot Mine, Trinity County 87
- Tehama County, chromite deposits in 132
- Temescal tin deposit, Riverside County 550
  - Tin Mine, Riverside County, photograph of 543
- Ten Cent Mine, Trinity County 87
- Tenner Mine, Trinity County 87
- Terrill Wm., prospect, Fresno County 309
- Texas Bar Mine, Trinity County 87
  - Co. 520
  - Mine, Nevada County 465
- Thayer and Mason Mine, Trinity County 83
- Thomas and Northern Bell claims, Nevada County 427
- Thomas Mine, Nevada County 465
- Thompson and Berry Mine, Nevada County 466
  - Brick Co. (see Eureka Brick and Tile Co.) 505
  - , Defiance and Independence Mines, Inyo County 566
  - Ranch Mine, Nevada County 466
- Thorn, W. E., A. Hausmann, J. Kruttschnitt, Jr., and J. A. Edman, cited 308, 322
- Thorne Mine, Trinity County 87
- Thorotungstite 239
- Three Creeks limestone deposit, Humboldt County 517
  - Johns Mine, Nevada County 466
  - Sevens Mine, Nevada County 466
- Tilden, Judd and O'Keefe Mine, Nevada County 466
- Timber in Trinity County 9
- Timmerman and McKenzie Mine, Trinity County 87
- Tin alloys 537
  - , bibliography on 553
  - Bucket No. 2 claim, Madera County 580
  - , economics of 536
  - , field determination of 545
  - , geology of 545
  - , history of 542
  - in Amador County 550
  - in California 531
  - in Humboldt County 550
  - in Inyo County 550
  - in Orange County 550
  - in Plumas County 550
  - in Riverside County 550
  - in San Bernardino County 551
  - in San Diego County 552
  - in Siskiyou County 552
  - in Trinity County 552
  - in Tulare County 552
  - in Tuolumne County 552
  - mining in California, future of 544
  - , occurrence of 545
  - ore, dressing 547
  - ore, origin of 546
  - ores, concentration of 547
  - , production of in California 543
  - situation in the United States, present and future 534
  - , total consumption of in the United States, diagram of 535
- Tinsley and Treloar Mine, Trinity County 87

Page
Tipperary Mine, Nevada County 466
Tip Top, San Luis Obispo County 141
Tobernite in San Bernardino County 491, 602
Toboggan Group, Kern County 290
Tola Group, Nevada County 466
Tolly Hill Mine, Trinity County 87
Tom Bell Mine, Trinity County 87
  Morton Consolidated Mine, Trinity County 87
Top Notch Mine, Trinity County 87
Toughnut Mine, Trinity County 87
Trabucco Tin Mine, Orange County 550
Tracy Mine, Nevada County 466
Transportation to Humboldt County 499
Treasure Box Mine, Nevada County 466
Treasury Group, Kern County 291
Treloar and Tinsley Mine, Trinity County 87
Triangle Mine, Trinity County 87
Tribute Mine, Nevada County 466
Tri-M Partnership 62, 87
Trinidad, San Luis Obispo County 163
Trinity Bonanza King Mine, Trinity County (see also United Trinity Mines) 88
  Chrome Mine, Trinity County 20
  Consolidated Mine, Trinity County 87
  County, agriculture in 8
  County, asbestos in 16
  County, barite in 16
  County, chromium in 16
  County, coal in 20
  County, copper in 23
  County, geography of 8
  County, geology of 10
  County, gold in 24
  County, granite in 67
  County, limestone in 67
  County, manganese in 67
  County, map of, back envelope of Report
  County, marble in 67
  County, mineral paint in 69
  County, mineral production of, table 14
  County, mineral resources of 8, 11
  County, mineral water in 69
  County, platinum in 69
  County, quicksilver in 70
  County, tin in 552
  County, water supply of 8
  Development Co. 87
  Dredging Co 62, 88
  Dredging Co., dredge, Trinity County, photograph of 63
  Farm & Cattle Co. 88
  Gold Mines, Trinity County 88
  Gold Mines, Inc. 36
  Mine, Trinity County 87
  Mohawk Mine, Trinity County 88
  River Mining Co. 88
Trought, M. E., and H. A. Franke, cited 347
True Blue Mine, Trinity County 88
  Fissure Mine, Trinity County 88
Tucker, W. B. 7, 201, 373
  , W. B., and R. J. Sampson, cited 286, 287, 291, 292, 293, 295, 296, 297, 298, 306, 307, 308, 309, 311, 312, 317, 325, 550, 551, 565
  , W. B., cited 16, 286, 290, 295, 297, 304, 307, 311, 313, 314, 317, 325, 344, 550, 551
Tulare County, tin in 552
  County, tungsten in 318, 588
Tule Belle Mine, Nevada County 466
Tuly Creek Chrome Mine, Trinity County 20, 88
Tungstar Mine, Inyo County (see also Crawford deposit) 298
Tungsten, bibliography 321
  Big Lode Group, Kern County 578
  Chief Mine, Kern County 578
  City Milling Co. 299
  deposits in Atolia District 283
  deposits in Kern County 312, 575
  deposits in the Kernville District 300
  deposits in the vicinity of Darwin 310
  , domestic tariff history of 234
  , economics of 230
  Hill Mine, Kern County 579
  , history of California 229
  in Alpine County 565
  in Eastern San Bernardino County District 305
  in El Dorado County 309
  in Fresno County 309, 565
  in Inyo County 567
  in Madera County 580

Page
Tungsten, bibliography—Continued
in Mariposa County 580
in Mono County 581
in Nevada County 315, 443
in the Bishop District, Inyo County 292
in the Kernville District 300
in Plumas County 581
in Riverside County 582
in San Bernardino County 316, 584
in San Diego County 317, 587
in Shasta County 318, 587
in the Weldon District 304
in Tulare County 318, 588
in Tuolumne County 319
King Group, San Bernardino County 308
King Mine, San Bernardino County 251, 303
, mineralogy of 237
, minerals containing 237
Mining Co. 300
, miscellaneous deposits of 309
ores, geology of 240
ores, method of treating 270
, price chart of 245
, prices of 232
, production of in California 278
production of the world, 1905-1938 244
Queen Group, Kern County 579
Resources of California 225, 565
resources of California, index map of 243
, strategic importance of 235
, survey of past prices 232
, tenor of the ore 240
, uses of 230
Tungstenite 239
Tungstite 239
Tungstore Mine, Tulare County 318
Tunnel Discovery Mine, Nevada County 466
Tuolumne County, tin in 552
County, tungsten in 319
Turner Group, Nevada County 466
, Hart and Adams Mine, Trinity County 79
Turtledove Mine, Nevada County 466
Twin Chrome Hill Mine, Trinity County 20, 88
Sisters Mine, Nevada County 466
Two Sisters and Wonder Mine, Trinity County 88
States Mining Co. 513
States Mining Co., photograph of 515
Tyler, P. M., cited 347
Tyson Mine, Trinity County 88
Uncle Sam Mine, Trinity County 88
Union Gulch Mine, Trinity County 88
Hill Mine, Nevada County 315, 443, 466
Hill Mine, Trinity County 88
Jack and Smuggler Mine, Nevada County 466
Mine, Nevada County 466
Mine, ore plant 276
Mine, San Bernardino County 254, 255
Nos. 1 and 2 Mine, Nevada County 466
United Banner, United Eagle and Macon Mine, Nevada County 466
Eagle, Macon and United Banner Mine, Nevada County 466
Lode Mine, Nevada County 466
States Bureau of Mines, cited 22, 332
States Flare Corp. 579
States Geological Survey, cited 253, 254, 257, 550
States Grant Mine, Nevada County 466
States Grant Lode mine, Nevada County 466
States Law Week, cited 169
States Supreme Court, decision on Power Permits 169
States Supreme Court renders far-reaching decision on power permits on 'Navigable' streams 169
States Vanadium Co., Mine, Inyo County, photograph of 572
States Vanadium Co., Inyo County, photograph of mill at 573
United Trinity Mines, Trinity County 63, 88
Tungsten Co., photograph of 246
Tungsten Copper Co. 246
Tungsten Copper Mines, San Bernardino County 317
Upgrade Placer Mine, Trinity County 64, 88
Upham Hydraulic Mine, Trinity County 64, 88
Upper Dutton Creek Mine, Trinity County 88
Eltapom Mine, Trinity County 88
Ural Mine, Nevada County 466
Uranus Mine, Nevada County 466
Uren, Edward C., cited 389
Uses of tungsten 230
Valdor Mine, Trinity County 88

Page
Valentine Consolidated Mine, Nevada County 466
  crystals in Kern County 602
Valley Gold Mines, Inc. 385
Vanderburg, W. O., cited 326
Van Matre and Bates Mine, Trinity County 74
  Mine, Trinity County 88
Van Ness Mine, Trinity County 88
Various Mine, Trinity County 88
Veatch and Bartholf Mine, Nevada County 441
Venecia Mine, Trinity County 64, 88
Ventura County, millerite in 491, 602
  County, pentlandite in 491
  County, pyrrhotite in 491
Vermont Extension claim, Trinity County 65
  Mine, Trinity County 65, 88
  No. 2 claim, Trinity County 65
Verne Tyler Mine, Tulare County 319
Viking Dredging Co. 66, 88
Viola Mine, Nevada County 466
Vulcan Lode Mine, Nevada County 467
W. Y. O. D. Mine, Nevada County 468
Wagner Mine, Trinity County 48, 83, 89
Waldeck Mine, Nevada County 467
Walker Tungsten Mines, Inc. 580
Wall Street Group, Kern County 304
Wallace and Mahoney Mine, Trinity County 82
  , Coumbs and Ingram Mine, Trinity County 77
  Mine, Trinity County 89
Wallings and Muller Mine, Nevada County 458
Wallington Mine, Nevada County 467
Walworth Mine, Nevada County 467
Ward Mine, Trinity County 89
Waring, C. A., cited 16, 246, 247, 344
  Clarence A., and E. Huguenin, cited 295, 298, 310, 312, 326
  G. A., cited 520
Washington Chief Consolidated Mine, Nevada County 467
  Mine, Nevada County 467
  Mine, Shasta County 587
  Tunnel Mine, Nevada County 467
Water supply of Trinity County 8
Watson Bar Mine, Trinity County 89
  Mine, Trinity County 89
Watt and Co., Mine, Nevada County 467
Waucoba Tungsten deposit, Inyo County 312
Weaver Creek Mine, Trinity County 89
  Dredging Co. 66, 89
  Dredging Co., dredge, Trinity County, photograph of 66
Webb, Robert W., and Wm. J. Miller, cited 324
Weitchpec Bar Mine, Humboldt County 515
Welch and Boyd prospect, Inyo County 293
Weldon District, Kern County, tungsten in 304
West Coast Tungsten Co. 574
  Coast Tungsten Co., photograph of mill at Keeler, Inyo County 574
  Delhi Mine, Nevada County 467
  Empire Mining Co. 386
  Norcross, San Luis Obispo County 143
  Point claim, Trinity County 65
  Point Mine, Nevada County 467
  Tower claims, Inyo County 300
  Virginia, Wheeling, and Ohio Mine, Nevada County 467
Western Gold Inc. 433
  Merger Mine, Nevada County 467
Westervelt, William Young, cited 326
Wetteran Ranch Mine, Nevada County 467
Wheaton and Stuart Mine, Trinity County 89
Wheeling, West Virginia and Ohio Mine, Nevada County 467
Whipple and Bartlett Mine, Nevada County 467
White and Johnson Mine, Nevada County 467
  Cloud Mine, Trinity County 89
  Feather, Siskiyou County 123
  Horse Mine, Humboldt County 515
  Oak Mine, Nevada County 467
  Rock Limestone deposit, Humboldt County 517
  Wings Mine, Nevada County 467
  Woman limestone deposit, Humboldt County 518
Whitmore Gold Mine, Trinity County 89
Whitney, J. D., cited 552
Why Not claim, Kern County 305
Wild Cat Chrome Mine, Trinity County 20, 89
  Cat Consolidated Mine, Nevada County 467
  Cat Mine, Trinity County 89
  West Mine, Nevada County 467
Wilker Mine, Trinity County 89
Wilkins, Edgar (Red) cited 565

Page
Willey Mine, Trinity County (see Vermont)
William Tell Group, Nevada County 467
    Penn Mine, Nevada County 467
    Terrill prospect, Fresno County 309
Williams, F. S., Mine, Trinity County 89
    Ranch deposit, Kern County 579
Willow Valley Mine, Nevada County 467
Wilson and Post Mine, Trinity County 85
    and Selvester Mine, Trinity County 86
Winfield Scott Mine, Nevada County 467
Winnie Mine, Kern County 291
Winslow, Mabel E., cited 344
Winston, W. B., cited 472
Wisconsin Gold and Silver Mine, Nevada County 467
    and Illinois Mine, Nevada County 467
Woil Mine, Nevada County 467
Wolf Mine, Nevada County 467
Wolflin, H. M. 403
Wolframite 237
    Mine, Alpine County 565
Woodberry Mine, Nevada County 467
Woodbury Mine, Trinity County (see also Garden Gulch) 67, 89
Woods Mine, Humboldt County (see Charles Mountain) 519
    Ravine Mine, Nevada County 462
Woodville Mine, Nevada County 467
Work Your Own Diggings Mine, Nevada County 467
Wotell Mine, Nevada County 467
Wren Ranch, Nevada County 442, 467
Wyoming Mine, Nevada County 468
Yellow Aster Mine, Kern County 291
    Aster Mine, Trinity County 89
    Diamond Mine, Nevada County 468
    Metal Group, Nevada County 468
    Rose of Texas Mine, Trinity County 89
    Surprise claim, Trinity County 67, 89
Yellowstone Group, Trinity County 33, 89
Yerba Buena Mine, Nevada County 468
Young America Mine, Nevada County 468
    G. J., cited 296, 326
    Mack and Old Mack Lode Mine, Nevada County 468
Youngs Valley Group, Siskiyou County 123
Yuba Canyon Consolidated Mine, Nevada County 468
    Consolidated Mine, Nevada County 468
    Mother Lode and Midas Mine, Nevada County 457
Zaca Mine, Alpine County 264, 565
Zeibright Mine, Nevada County 380, 431
Zeilbright Mine, Nevada County 468
Zinc Saddle, Del Norte County 120

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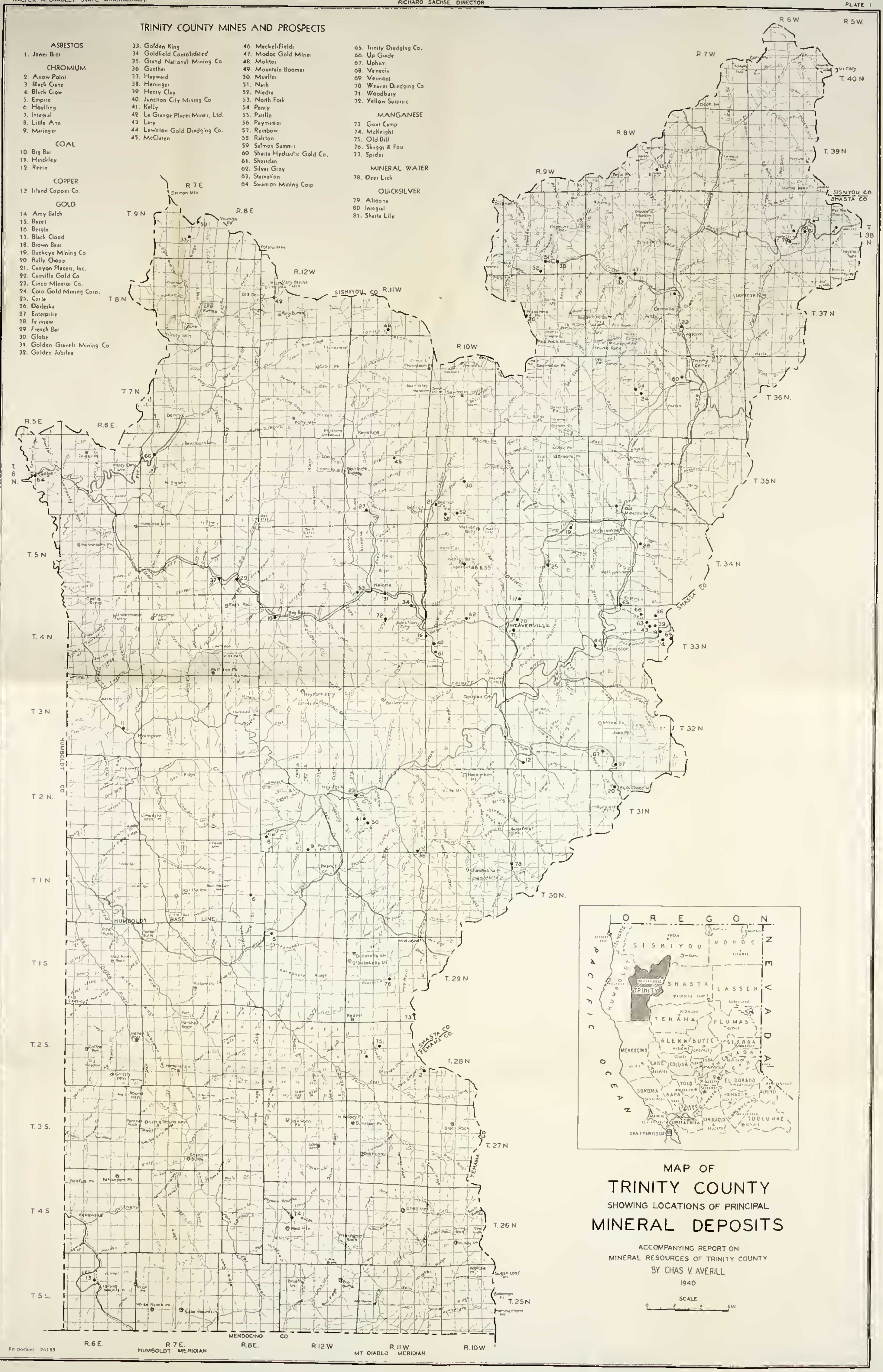
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SISKIYOU CO.
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TEHAMA CO
HUMBOLDT CO
MENDOCINO CO.
HUMBOLDT BASE LINE
WEAVERVILLE
Junction City
Lewiston
Trinity Center
Carrville
Minersville
Helena
Big Bar
Denny
Hayfork
Douglas City
Hyampom
Salmon Mtn
Potato Mtn
Trinity Mtn
Island Mountain
R.6 E.
R.7 E.
HUMBOLDT MERIDIAN
R.8 E.
R 12 W
R.11 W.
MT DIABLO MERIDIAN
R.10 W
O R E G O N
N E V A D A
P A C I F I C
O C E A N
SISKIYOU
MODOC
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
LAKE
COLUSA
YOLO
EL DORADO
SONOMA
NAPA
SOLANO
AMADOR
MARIN
CONTRA COSTA
SAN JOAQUIN
CALAVERAS
TUOLUMNE
SAN FRANCISCO
SCALE
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TRINITY COUNTY MINES AND PROSPECTS

ASBESTOS

1. Jones Bros

CHROMIUM

2. Arrow Point
3. Black Crane
4. Black Crow
5. Empire
6. Hoelling
7. Integral
8. Little Ann
9. Maringer

COAL

10. Big Bar
11. Hinckley
12. Reece

COPPER

13. Island Copper Co.

GOLD

14. Amy Balch
15. Bazel
16. Bergin
17. Black Cloud
18. Brown Bear
19. Buckeye Mining Co
20. Bully Choop
21. Canyon Placers, Inc.
22. Carrville Gold Co.
23. Cinco Mineros Co.
24. Cora Gold Mining Corp.
25. Corla
26. Dorleska
27. Enterprise
28. Fairview
29. French Bar
30. Globe
31. Golden Gravels Mining Co.
32. Golden Jubilee
33. Golden King
34. Goldfield Consolidated
35. Grand National Mining Co
36. Gunther
37. Hayward
38. Heninger
39. Henry Clay
40. Junction City Mining Co
41. Kelly
42. La Grange Placer Mines, Ltd.
43. Lacy
44. Lewiston Gold Dredging Co.
45. McClaren
46. Meckel-Fields
47. Modoc Gold Mines
48. Molitor
49. Mountain Boomer
50. Mueller
51. Nash
52. Niedra
53. North Fork
54. Perry
55. Patillo
56. Paymaster
57. Rainbow
58. Ralston
59. Salmon Summit
60. Shasta Hydraulic Gold Co.
61. Sheridan
62. Silver Grey
63. Starvation
64. Swanton Mining Corp
65. Trinity Dredging Co.
66. Up Grade
67. Upham
68. Venecia
69. Vermont
70. Weaver Dredging Co.
71. Woodbury
72. Yellow Surprise

MANGANESE

73. Goat Camp
74. McKnight
75. Old Bill
76. Skaggs & Foss
77. Spider

MINERAL WATER

78. Deer Lick

QUICKSILVER

79. Altoona
80. Integral
81. Shasta Lily

MAP OF

TRINITY COUNTY

SHOWING LOCATIONS OF PRINCIPAL

MINERAL DEPOSITS

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